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THE GROSS AND NET EARNINGS OF RAILWAYS in the United States for the month of March and the first three months of 1891, according to the *Financial Chronicle*, are as follows:

	March. (140 roads).		Three Months. (181 roads).	
	1891.	1890.	1891.	1890.
	$	$	$	$
Gross Earnings....	53,049,806	52,656,175	193,005,003	185,332 838
Oper. Expenses....	37,031,522	36,726,853	136,849,563	131,477,561
Net Earnings.....	16,036,284	15,929,322	56,155,440	53,855,277

This is, for March, an increase of 0.74 % in gross and 0.67 % in net, and for the three months an increase of 4.14 % per cent. in gross and of 4.27 % in net. The detailed figures for groups of roads and separate systems show, however, that the results of operations have not been uniform. Arranged by groups, the Pacific roads show gains in net of 10.39 % for March, and for the three months of 47.42 %, or in amount $3,023,086, an increase larger than the aggregate increase for the total number of 181 roads. The Southern roads and the coal roads also exhibit gains of 19.25 % and 2.9 % respectively for March, and of 7.3 % and 8.17 % respectively for three months. The groups showing the largest losses in net earnings are Southwestern and Northwestern. Their losses aro 22.43 % and 9.71 % respectively for March, and 19.39 % and 11.17 % respectively for three months.

ANOTHER "BIG BLAST" is in prospect at the South Bethlehem, N. Y., stone quarries of Mr. P. CALLAHAN. In ENGINEERING NEWS of Sept. 21, 1889, we illustrated a previous blasting operation at the same quarry, in which 1,959 lbs. of dynamite threw down from 20,000 to 25,000 tons of rock. This output is to be exceeded by a still heavier charge that is expected to double the volume of rock thrown down in 1889. The day fixed for "firing" is June 16, and a number of engineers, state officials and others are expected to be present. The quarry is in a limestone formation and the rock is used chiefly for macadam and asphalt road making. The crusher plant has a capacity of 1,000 tons daily.

THE PRODUCTION OF IRON AND STEEL IN RUSSIA for the 10 years of 1879-88, according to an official statement, shows a moderate increase. The largest gain has been in the production of pig iron, which amounted in 1888 to 230,000 tons, a gain of 54%. Up to 1886 the increase was slow, being only 90,000 tons, but since that time there has been rapid progress. The production of bar iron shows only a small gain, it amounting to only 81,000 tons in the 10 years. The total production of 1888 amounted to 350,000 tons, only 4,000 greater than that of 1887. The production of steel in 1888, like bar iron, shows a small increase over the previous year, but for the 10 years has been very fluctuating. In 1880, 1885 and 1888 the total production amounted to 300,000 tons, 180,000 tons and 211,000 tons respectively. Of the quantity produced in 1888, 1,100 tons were made by casting, 2,300 tons by puddling, 49,500 tons by the Bessemer process, 154,000 tons by the Martin process, and 4,100 tons by the Franche Comtè process. The number of steel works in the country was 32. About 61,000 tons of steel rails were produced. The domestic product supplied in 1888 90% of the total consumption of pig iron, 85% of the bar iron, and 96% of the steel.

THE NICARAGUA CANAL HARBOR ENTRANCE at Greytown, Nicaragua, is rapidly deepening under natural agencies acting in consort with a half-completed pier. On May 20 the steamer Brattan, with 1,000 tons of coal from Pensacola, crossed the bar into the harbor. The Brattan drew 12 ft. of water and the lead showed 15 ft. in the entire channel. The troublesome "outer bar," which lately had only about 9 ft. of water upon it, has broken through.

A CIVIL SERVICE EXAMINATION will be held at Washington, D. C., commencing at 9 A. M., for an architectural draftsman at a salary of $1,800 per annum. Blanks for application will be furnished by JOHN T. DOYLE, Secretary, Washington, D. C

THE COMMITTEE ON RAILWAY SAFETY APPLIANCES, appointed at the Convention of State and Interstate Railway Commissions in March, held its first meeting in Washington, April 28. It was decided that information should be obtained on the following subjects:

(1.) The total number of freight cars owned, leased or otherwise controlled by each company, and how many are equipped with automatic couplers. (2.) The kinds of couplers used and the number of cars with each kind. (3.) The kind of couplers each company now causes its freight cars to be equipped with. (4.) The number of freight cars each company has equipped with train brakes and the names of the brakes used. (5.) The number of locomotives each road owns, leases or controls, and the number equipped with the driving-wheel brakes. (6.) The opinion of railroad officials as to the way in which the equipment of freight cars with uniform automatic couplers can best be hastened.

A circular requesting this information is to be sent to all railway companies carrying interstate commerce, and another requesting communications on this subject is to be sent to organizations of railway officials and employees. Correspondence may be addressed to EDWARD A. MOSELY, Secretary Interstate Commerce Commission, Washington, D. C. If a hearing is desired by any organization, notice should be given the committee before Aug. 1. The next meeting of the committee was set for Nov. 10, 1891, in New York city; but the chairman is authorized to call a meeting before that date if found necessary. The members of the committee are GEO. C. CROCKER of Massachusetts, chairman; JAS. C. HILL, of Virginia; SPENCER SMITH, of Iowa; WM. E. ROGERS, of New York, and JOHN H. KING, of South Dakota.

As our readers know, the statistics which the committee proposes to collect, with the exception of those relating to the use of driver-brakes, have recently been gathered by this journal, and were published in our issues of April 25 and May 2.

THE DYNAMITE THROWER Vesuvius, in the later tests at Fortress Monroe, did not acquit herself as well as expected. In all previous test the shots were fired from a stationary ship. On May 20 three shots were fired at a fixed target at one-half mile range with the *Vesuvius* moving toward the target with a speed of about 10 knots, and three shots at a moving target, at the same range, with the *Vesuvius* approaching at a 17-knot rate, while the target was moving transversely to the line of the dynamite thrower. The shells were loaded with sand only, the object being to test range and accuracy. The summary of results, as given by Commander R. D. EVANS, U. S. N., was as follows: Stationary target: first shot, lateral deviation slight, range 20 yds. beyond target. Second, lateral deviation none, range 200 yds. beyond. Third, lateral deviation none, range 250 yds. beyond. Moving target, first shot, lateral deviation 30 yds. to the left, range 150 yds. too short. Second, lateral deviation none, range 450 yds. beyond. Third, lateral deviation none, range 300 yds. too short. Other tests are to follow, and if they are equally unsatisfactory, the dynamite tubes may be placed in a shore battery on the Pacific coast, and the Vesuvius fitted with torpedo tubes in the regular way.

THE WORST ACCIDENT OF THE WEEK was due to the work of train wreckers, and occurred in the yards at Jonesboro, Ark., on the St. Louis, Arkansas & Texas Ry., on May 24. The northbound passenger train was derailed by a switch partially thrown and spiked down. The locomotive was badly wrecked, and two men in the cab were killed, while a third was badly scalded.——Three other attempts at train wrecking are reported; one on the Wisconsin Central, 20 miles north of Marshfield, Wis., one on the Louisville & Nashville, near Portland, Tenn., and one on the Wabash Ry., a mile east of Wabash, Ind. In each case obstructions were placed on the track; but in the first two cases the train was stopped in time to escape an accident, and on the Wabash the derailment fortunately did little harm.

A WOODEN HIGHWAY BRIDGE at Tyrone, Pa., fell on May 22. A crowd had gathered on the bridge to watch a circus parade, and the weight proved too much for the structure. Several were seriously injured, though no one was killed.

THE CHICAGO GRADE-CROSSING QUESTION is again being taken up by railway and city authorities. The railways have presented a plan for crossing four of the chief streets, wherein they propose to elevate the tracks 7 ft. and construct a subway for street traffic, if the city will consent to depressing the streets 7 ft. This will avoid the high retaining walls and consequent damage to property that would otherwise be needed. The Mayor, City Commissioner ALDRICH and City Engineer COOKE are favorably impressed with the plan. Grade crossings in Chicago now cost about 400 lives per annum.

A GAS-ENGINE, it is said, will be used for turning the 200 ft. steel double track draw span of the Chicago & Northwestern Ry. over the Milwaukee River. A gaspipe is run under the river and up through the center of the bridge, with a storage tank on the bridge holding a half-day's supply, for use in case of accident to the main. Hand turning apparatus is also supplied. The bridge is to be open for travel by June 1.

RIVER MINING BY DREDGES, which has been successful in Australia and unsuccessful in this country, is about to be tried on the gravel bars of the Jefferson and Madison rivers in Montana, says the *Mining and Scientific Press*. Very large and powerful dredges are being built by a company principally composed of Denver capitalists. New machinery is also being put on the dredge on the Carson River, Nev., the machinery formerly in use being faulty. The bed of the Carson will soon be prospected by this dredge.

THE DAY RAILWAY CONSTRUCTION CO. has been formed in Chicago, with a capital of $10,000,000. Prest., W. G. PURDY; Chief Engineer, ST. JOHN V. DAY, and Associate Engineer, ISHAM RANDOLPH. The Day system of railway is intended for elevated service, and is operated in two stories, thus keeping the local and express traffic separate. As vaguely described in the daily press, the structure is mainly composed of steel cables supporting floor-beams, with the members so combined that, "a passing train produces local stiffness in the structure." It is claimed that it is light and strong, graceful in outline, less costly than other systems, and with the special cars used is capable of developing great speed. Most excellent names are included among its officers.

Notes on the Nicaragua Canal.

On Saturday, March 14, the Hon. WARNER MILLER, President of the Nicaragua Canal Construction Co., several guests and representatives of the press sailed from New York for the port of Greytown on the Steamer Aguan. The purpose of the expedition was that the President of the company might see for himself the progress of work on and about the canal, and the conditions under which it was being conducted, and that through the press the people of the United States might be made better acquainted with the details of the most important engineering and commercial enterprise of our time—for such this canal undoubtedly is.

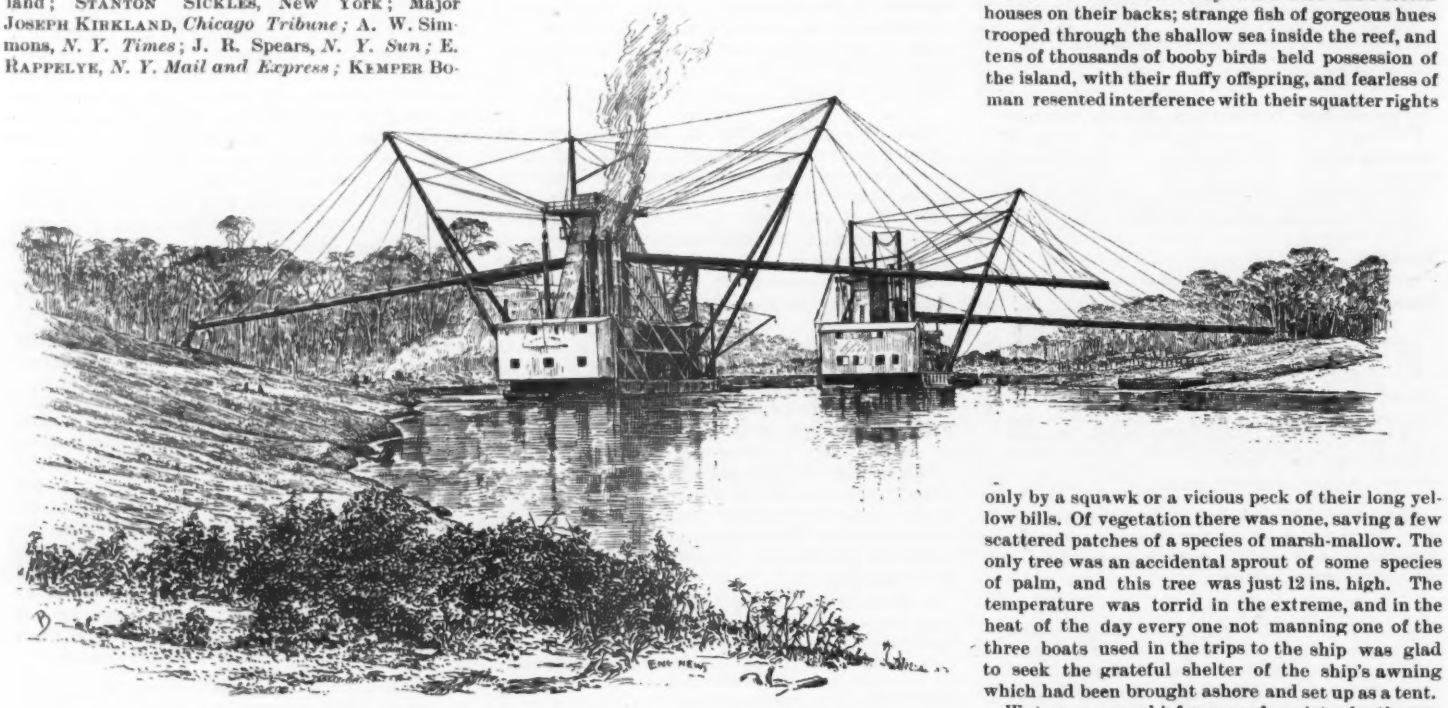
This party was made up as follows: Hon. WARNER MILLER, President Nicaragua Canal Construction Co.; Hon. C. L. MERRIAM, New York; CHARLES WATROUS, New York; G. HILTON SCRIBNER and daughter, New York; Major C. E. DUTTON, Ordnance Corps, U. S. A.; Lieutenant GUY HOWARD, U. S. A.; W. J. MARRIN, New York; H. F. DONALDSON, Assoc. M. Inst. C. E., civil engineer Manchester Canal, and H. F. GOOCH, his assistant, England; STANTON SICKLES, New York; Major JOSEPH KIRKLAND, *Chicago Tribune*; A. W. Simmons, *N. Y. Times*; J. R. Spears, *N. Y. Sun*; E. RAPPELYE, *N. Y. Mail and Express*; KEMPER BOCOCK, *N. Y. Press*; Hon. C. L. MCARTHUR, *Troy Budget*, and D. MCN. STAUFFER, Editor of ENGINEERING NEWS.

The start from New York, the speeches made, and the expressions of good will and interest in the canal enterprise uttered by a host of Senator MILLER'S friends who assembled to see him off on his way South, have all been duly chronicled in the daily press and they would be out of date here. It is sufficient to say that our voyage was uneventful until after Kingston, in Jamaica, had been left to the north of us. High seas, cold weather and a drizzling rain as far south as the Florida coast, at least, were our disagreeable portions; but the enforced retirement to smoking-room and main saloon developed unexpected resources of entertainment in our company, and the time passed rapidly enough.

At Kingston several days were spent in visiting a few of the points of interest thereabouts, in enjoying what was to many of our party the first sight of tropical plant life, and in critically examining the products of the island of Jamaica, most creditably shown at the exhibition now open. On March 23 the Aguan left the port of Kingston, or rather attempted to leave, for here began the chapter of our misadventures. By some blunder of our negro pilot the ship was backed so as to foul the cable of a vessel in port; the resultant three or four turns around our screw necessitated an interchange of sentiments between the respective ship captains, the services of divers and a delay of about 12 hours, a delay that had far reaching consequences, as was soon evident.

Until Thursday, March 26, all went smoothly, for the Caribbean Sea was almost like a mirror, a long gentle swell alone disturbing its surface. But under this treacherous exterior were concealed strong currents setting onto reefs of coral rock, some of them the most dangerous in this sea. The bottom of our ship had not been cleaned for nine months, and as a consequence the Aguan never a fast ship, rolled along at a provokingly slow pace, and we were at least three days behind the time of our expected arrival at Greytown.

In latitude 12° 30' North and longitude 80° West lies Roncador Reef, "The Snorer," so named from the booming of a mighty surf upon miles of coral rock that just reach the surface of the sea. There are no lights on this reef, no marks of any kind saving the battered hulls and ribs of what were once good ships. In his haste to make port our navigator laid his course, "they say," to pass about 25 miles to the windward of this reef, instead of keeping some 40 miles or more away, as the more cautious advise. The set of the current toward the reef is here unusually strong, and as a result the steamer Aguan and her fateful expedition landed about 3.20 on Thursday morning, high on the Roncador Reef about 1½ miles inside the Eastern point.



DREDGES "CITY OF PARIS" AND "M. A. SLAVEN" AT WORK IN THE NICARAGUA CANAL, AT GREYTOWN, NICARAGUA.

Fortunately the seas, even on the rocks, were not high; and striking as she did, at full speed, the Aguan ran up so completely on the coral shelf that she settled down upon a fairly even keel. There was no mistaking the ominous sound made by sharp rocks tearing through the ship's plates, nor the snapping of steel stays as the masts seemed to be forced upward by the distortion of the hull. Our ship was a wreck on a coral reef, about 170 miles from the nearest point on the mainland, or the so-called Mosquito Coast of Central America.

Never before, perhaps, was there a shipwreck destined to have its story so fully told to the world as this. Many of the chief daily papers of the United States had their best correspondents literally "on the spot," book in hand and Kodak at side, ready and anxious to note every incident as it occurred. The correspondents were true to their calling. In the midst of the rude awakening of that morning, when men and women rushed to the deck, only knowing that their ship had struck and was a wreck, and not knowing what dangers were yet to be encountered, we heard one faithful scribe gleefully call out: "I say, boys, here's an item at last; something worth writing about!"

Under these circumstances it is entirely unnecessary to tell a tale already better told many times over, and familiar to our own readers. It will be sufficient to say that when daylight came we saw within the western rim of the reef a very small island, about 7 miles away. With some little trouble and in leaking boats all the passengers and nearly all the ship's crew were transferred to the land, and by succeeding trips food and water enough to sustain life for a week or more were gradually landed. The first officer of the Aguan with four men were at once sent away to the mainland for help in the best boat, and after that there was nothing to do but to land stores from the ship, as long as the sea permitted, and to wait.

Our new-found world was not unbounded in area; it was quite the reverse, in fact, for in extreme dimensions Roncador Island was about 1,800 ft. long by 800 ft. wide, and in elevation little more than 4 ft. above the level of the sea. But it was an interesting world, nevertheless, built up out of the sea by that wonderful worker, the coral insect. Its shores were strewn with strange and beautiful shells; hermit crabs wandered everywhere with their stolen houses on their backs; strange fish of gorgeous hues trooped through the shallow sea inside the reef, and tens of thousands of booby birds held possession of the island, with their fluffy offspring, and fearless of man resented interference with their squatter rights only by a squawk or a vicious peck of their long yellow bills. Of vegetation there was none, saving a few scattered patches of a species of marsh-mallow. The only tree was an accidental sprout of some species of palm, and this tree was just 12 ins. high. The temperature was torrid in the extreme, and in the heat of the day every one not manning one of the three boats used in the trips to the ship was glad to seek the grateful shelter of the ship's awning which had been brought ashore and set up as a tent.

Water was our chief source of anxiety, for the seawater had entered the great tank aboard the Aguan, and the comparatively small supply contained in the deck tank and another in the bathroom was soon transferred to the island, and in great part already consumed by the 93 thirsty souls on this hot coral beach. On the third day two wells were commenced in the heart of the island, and to our inexpressible relief water was found. It was heavily charged with lime from the coral, and was slightly brackish; but coffee and tea—of a bad quality—could be and were made with it, and in an emergency it would have satisfied thirst for some time.

To make a long story short, on the late evening of the fifth day after our enforced landing on Roncador, our eyes were gladdened by the lights of an approaching vessel, coming from the mainland. The lights belonged to a small schooner manned by Carib turtle-hunters, who brought us the welcome intelligence that our small boat had reached Old Providence Island and had departed for the mainland. In the language of HENRY E. DIXEY, in his burlesque on the landing of COLUMBUS, "we were discovered" at last, and our deliverance was only a matter of time. In the afternoon of the next day the Presidente Corazzo, a coasting steamer, hove in sight and we hastily made our preparations to leave the island. And a day later the U. S. S. Petrel, Lieutant-Commander W. H. BROWNSON commanding, reached the Roncador from Greytown, whence a rumor of our wreck coming down the coast had sent the ship on its voyage of relief. The Corazzo was a small vessel of only 4 ft. draft and developed a capacity for rolling that was little short of the marvelous. But she at last safely landed us at

Greytown; not only ourselves, but all of our baggage, inclusive of the dress suits and general finery that had been brought along for purposes of official dress parade in Nicaragua. Thus ended a shipwreck that, while it had its anxious moments, and with a heavier sea might have left some of us with a different tale to tell, was really little more than a pleasant experience, without loss of life or baggage, or even passing ill health.

Early on the morning of April 2 the Corazzo passed over the bar and into Greytown harbor, making a landing at the canal company's pier at La Fe. Senator MILLER and his party were warmly welcomed by Chief Engineer MENOCAL, Division Engineer DAVIS and the members of the engineering and medical staff stationed at this point, and all were soon most comfortably housed in the Headquarters building.

La Fe itself is merely an older name for what is now known as the town of America, which is already equipped with its governor, police and official staff. The older Greytown lies about 1½ miles off, at the other end of the harbor and near the present mouth of the San Juan River. The entrance to the Nicaragua Canal is near La Fe, and about this entrance are clustered the work and repair shops of the construction company, the barracks for men, storehouses, landing pier, etc., and in fact all there is of La Fe.

North of the landing pier the beach has been cleared of trees and bush for a width of about 1,000 ft. from the sea and for a length of over one mile. Along this stretch of sandy beach and fully exposed to the ever-blowing N. E. trade winds, lie in a long line other storehouses, the headquarters of Chief Engineer MENOCAL and of his engineering staff, and at the extreme north of all is the main hospital and its various attendant structures. The situation is a delightful one, and the cool sea breeze that necessitated blankets at night was suggestive rather of Long Branch than of a camp on the so-called "deadly" Mosquito Coast.

The buildings themselves were plain but substantial two-storied structures of yellow pine and corrugated iron, elevated from the ground on posts and surrounded by wide porches and balconies. There was literally nothing of the handsome exterior and dainty interior, the planting of palms and walks and drives for "the Director General," that characterized the Panama Company's headquarters, seen later. But there was an atmosphere of business-like economy about the La Fe buildings that augured well for the future conduct of affairs at this point. They provided for both the comfort and efficient work of canal employees, but stopped short of unnecessary luxuries.

Quite naturally the hospital was one of the first points of interest examined by some of our company; for in this climate the health of present and prospective employees would undoubtedly be a prominent factor in the economical and rapid conduct of work upon the Nicaragua Canal. We had all studied the deadly record at Panama, not only in the attempted constructions of the "sea-level" canal, but in the earlier building of the Panama railroad; and along with the world at large were ready to believe that the bad reputation of the Isthmus extended to the whole Mosquito Coast, of which Greytown is physically though not politically a part.

To better understand the conditions expected and our own story of those we found, some further description of the country surrounding the Atlantic entrance to the canal is necessary. Greytown lies in latitude 10° 55' north, and longitude 83° 42' west from Greenwich. For about 10 miles inland the country is very low, and is intersected by lagoons or covered with water from the heavy rainfall of this section. The vegetation is a dense, tropical jungle. Palms of many varieties are mingled with trees of taller growth, with wide-spreading, buttressed roots, and above and below all other vegetation seems to be bound together in a confused tangle by the *lianas* or tough vines, that vary in size and strength from whip-cords to a diameter that literally strangles the life out of the great trees that first gave them support. There is neither trail for man nor track for mule leading in and from Greytown. The only means of access is by canoes; by a small steamer which has to go outside and enter the Colorado mouth to get into the San Juan, or now by the canal company's railway which crosses the "impassable swamp" lying between the coast and the first high ground.

The annual temperature ranges between 78° and 95° Fahr., but this is tempered by the constant northeast trade winds. The rainfall on the Atlantic slope of the Central American divide is exceedingly heavy, as the following data collected from the canal company's records will show. This record is kept at the main hospital at America and at one of the camps on the Deseado basin, about 12 miles inland, by J. EDWARD STUBBERT, chief surgeon of the Construction Co. The original notes the daily rainfall, but we have condensed this so as to show only the monthly totals and the greatest downpour in any one day in the month:

MONTHLY AND GREATEST DAILY RAINFALL IN INCHES AT AMERICA, ON THE ATLANTIC COAST, AND IN THE DESEADO BASIN, ABOUT 12 MILES INLAND.

Date.	America.		Deseado Bs'n.		Daily Aver.	
	M'thy Total.	Daily Max.	M'thy Total.	Daily Max.	America.	Deseado.
Dec. 1889	64.39	10.30	51.52	.....	2.07	1.66
Jan. 1890	26.80	2.80	32.24	2.90	.86	1 04
Feb. "	6.32	1.08	9.48	1.51	.22	.33
Mar. "	5.93	2.50	9.06	1 72	.19	.28
April "	18.11	6.05	22.46	7.12	.60	.74
May "	4.93	1.70	8.25	3.50	.16	.96
June "	41.50	3.64	30.04	3.35	1.30	1.00
July "	52.59	5.02	33.51	5.25	1.69	1 08
Aug. "	36.61	3.87	26.56	3.90	1.18	.85
Sept. "	13.29	3.00	13.73	2.20	.44	.45
Oct. "	24.36	4.00	19.01	3.00	.78	.61
Nov. "	25.55	4.10	18.99	2.85	.85	.63
Dec. "	41.65	7.65	.....	7.70	1.37	1.28

Taking the totals for the first twelve months in the above table, we find that the annual rainfall for the points and dates given was 320.48 ins. at America, and 274.85 ins. in the Deseado valley. This is equivalent to 26.6 ins. and about 23 ins. respectively per month. Another feature of this record is that while there is undoubtedly a distinct rainy season, there is practically no month in the year without at least one heavy rain. The maximums show rainfalls in one day of 7.70 and 10.30 ins., a downpour which must be felt to be thoroughly appreciated.

While treating of rainfall we might as well add that it is only on the Atlantic watershed of Nicaragua that this excessive rainfall is found. On the Pacific division of the canal, between the lake and the ocean, the average annual rainfall is about 70 ins. The records kept for a number of years by Dr. FLINT, of Rivas, show a range of 30 to 90 ins., with a rainy season between May and November. As on the Atlantic slope the rains are sudden and heavy when they do occur, the temperature on the Pacific side ranges from 70° to 87°. During the year 1890 the rainfall about Managua, between Lakes Nicaragua and Managua, was phenomenally low, being only 14 ins. for the year; and as a consequence the country was dry and dusty, with all manner of vegetation parched and withered. Previous to our landing the Atlantic slope had also been unusually dry, and the swamp, through which the company had built its railroad, between San Juan and Bernardo lagoons, in 4 ft. or more of water, was practically dried out. This railway work was commenced in June, 1890, during the heavy rains of that season.

With this brief outline of physical conditions about Greytown and along the line of the canal, we can return to the hospital and the records found there. The main hospital at La Fe is similar in its construction to the other buildings described, plain but substantial; it is as well equipped in all essential departments as would be a similar structure in New York City. The officers' hospital is a two-storied house 30 × 48 ft. in dimensions, and the laborers' hospital is also two-storied and 20 × 93 ft. Cots are provided for 125 patients in airy, well ventilated rooms, and in separate buildings are mess halls for patients, nurses and doctors' quarters, laundries, etc.

The chief surgeon is J. EDWARD STUBBERT, M. D. and at the time of our arrival, with 600 officers and laborers at work on the canal, we found him with five assistants devoting their unremitting attention to just three patients, and one of these was a surgical case. In fact, the arrival of Senator MILLER'S party doubled the demands upon the services of the medical staff by consigning three members of that party to their care. So anxious, indeed, was Dr. STUBBERT to find something to do that the writer was somewhat appalled, on his first visit, when he was handed a daintily wrapped up package of medicine, and directed to take "one dose every hour." We later found that it was intended for another member of the expedition; but the attempted dosing of a man who was "disgustingly well," as one party expressed it, spoke volumes for the professional anxiety of the doctor.

An inspection of the hospital returns and records showed that while the extreme paucity of patients found by us might be a somewhat unusual state of affairs, the general health record was extremely gratifying. Taking the returns for the fifteen months ending Jan. 1, 1890, and covering a very wet season, when over 1,500 men were at work, we find the following:

Medical cases	1,347	Discharged cured	1,646
Surgical cases	322	Deaths	23
Total	1,669	Total	1,669

Of the above 23 deaths only 12 were due directly to climatic diseases. But taking all the deaths, from whatever cause, the ratio of deaths to total cases treated was only $\frac{7}{10}$ of 1%. In the total of medical cases, 283 were chargeable to remittent, and 433 cases to intermittent fevers. This record is a remarkable one, of which the medical staff can be justly proud, and upon which the company's officers and all interested in the future of the canal can well congratulate themselves.

In short, all evidence so far indicates a region far more healthy than the fatal Isthmus, and conditions very favorable in the all-important essential of the general health of future employees on the canal. But it is only just to say that something besides natural conditions is responsible for the records quoted. Warned by the fearful mortality at Panama and the experience along that ill-fated canal, the officers of the Nicaragua Canal have, from the start, devoted their attention quite as much to preserving the health of their workmen as to treating disease after it had made its appearance.

While the hospital service is remarkably well organized, certain sanitary laws are laid down and rigidly enforced outside of the hospitals. To begin with, each surgeon is also a sanitary inspector, and no camp for officers or men can be located nor a water supply be utilized until both have been carefully inspected and reported upon by the medical staff. Then the workmen, who are chiefly negroes from Jamaica, are both housed and fed by the company, and proper shelter and wholesome food are thus assured. By keeping the workmen in regular camps, under official inspection, it is possible to keep these camps clean, and to prevent, to a great extent, the straying from quarters and the dissipation that is so fatal in this climate.

In a word, the canal company recognizes that rigid discipline with the labor employed is not only the price of efficient work, but also of general good health. In this view of the requirements of the case the Nicaragua Canal Company are pursuing methods diametrically opposed to, at least, the later practice on the Panama Canal. There, the same Jamaican negro was paid his full wages, generally for "stint work," and permitted to feed and to take care of himself. As a consequence he lived in a "shack" of palm leaves, located anywhere his fancy pitched it, or was herded in barracks provided by the contractor, but unpoliced and with every unsanitary surrounding possible. For food, anything would do that was cheap and most easily secured, as this was secondary to the means of providing for drink and other forms of dissipation to which this race is prone. Under these circumstances, even under equal climatic conditions, it was little wonder that the hospital was so often only the gateway to Monkey Hill and the many other burying-grounds on the Isthmus. The Frenchmen literally spent untold millions upon their hospitals at Colon, Panama, Taboga and along the line of the canal; but less hospital and more care of men before they entered the hospitals would doubtless have vastly improved their mortality returns.

We will now come back to the Atlantic entrance to the canal and the work in that neighborhood, in the inspection of which the first week ashore was spent. Naturally, the work in progress for making a ship channel through the Greytown bar first attracted attention. For the benefit of those who have not studied this problem we will say that for almost 30 years the old Greytown harbor has been practically a fresh-water lagoon, fed by the waters of the San Juan River and cut off from the sea by a

sandbar extending above high-water level. This bar is not the result of silt carried down by the San Juan River, as some suppose. This river enters the old harbor nearly two miles from the bar, and, while some sand is depcsited about its immediate mouth by the sudden reduction of velocity due to the river emptying into a wide bay, soundings taken over a long period of years show that there is little or no change in the depth of the harbor proper midway between the river and the bar. It is also evident that stopping the flow of the Colorado mouth of the San Juan and turning all the water that now escapes to the sea by that mouth back into the old San Juan channel would be of little or no permanent value in maintaining a channel across Greytown bar. All the velocity due to even this increased volume of water would be so efficiently checked by passing through the two miles of wide bay that before the bar was reached its scouring value would be utterly lost.

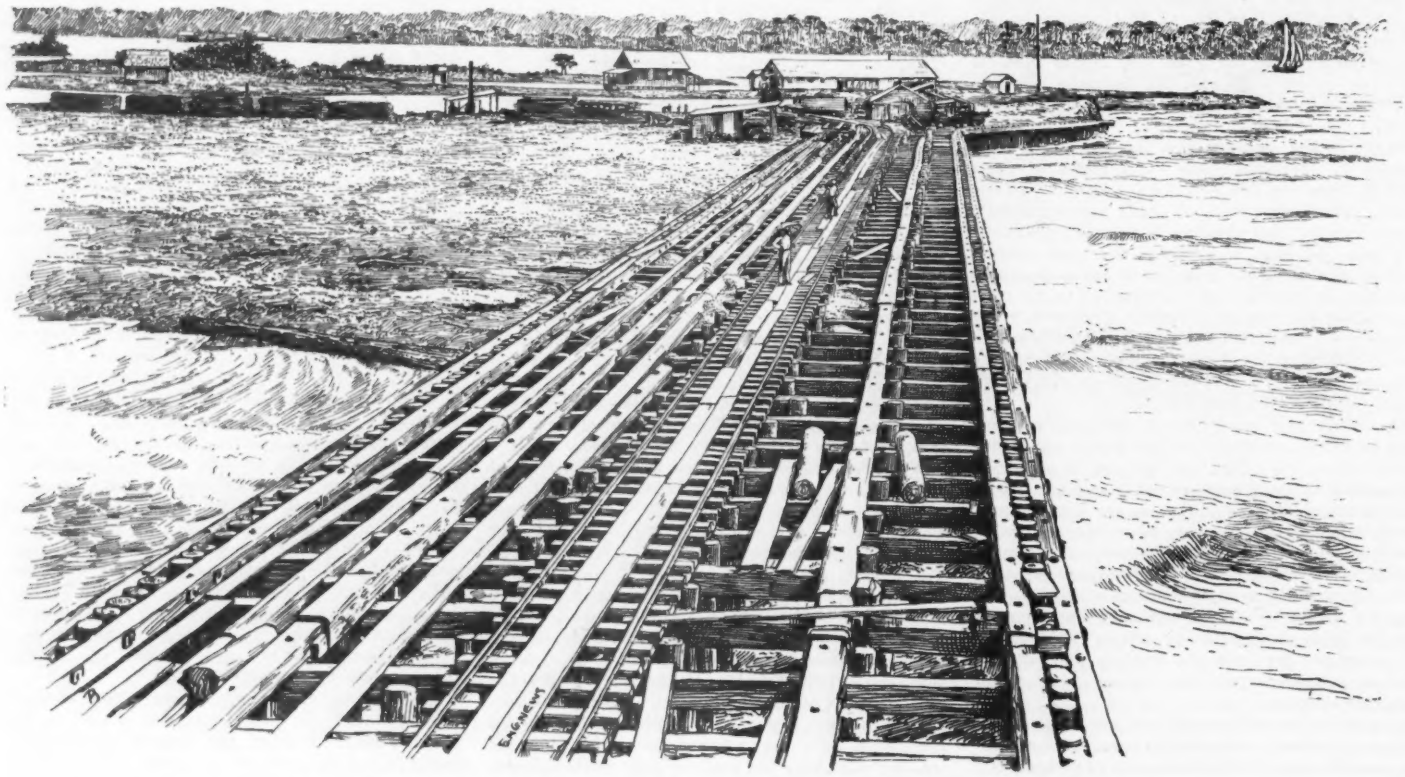
The bar now shutting off the old, narrow channel of 1853 is due entirely to forces acting from without and not from within the coast line. The wind blows almost constantly upon this shore from an easterly direction, obliquely across the old channel. The long swells from the Caribbean Sea break on this beach with enormous force and carry with them great quantities of sand. This sand moves from east to west, and, in the case of the old channel, was deposited around the western end of the spit, or on the east side of the channel. The west side of the entrance was cut away somewhat, but the effect was eventually to change the course of the channel from one at right angles to the bar to a direction more and more oblique to this bar, until finally the spit advanced from the east until the western shore was reached and the channel was closed to navigation.

This same method of proceeding repeats itself every time an excessive flood in the San Juan raises the water in the harbor until it breaks through the bar. The new-made channel is at first normal to the bar; but as the flood subsides and the wind and waves bring in the sand from the east, the channel turns obliquely as above described, until the bar again blocks it up.

To secure a permanent and safe entrance to the ship canal under the existing conditions is evidently no light engineering task, and the works opposed to the pounding of this heavy sea and to the drifting sands must be very substantial and very tight. But that it is possible within economical limits, we believe the work already accomplished sufficiently shows.

Chief Engineer MENOCAL has long and carefully studied the natural forces operating on this coast, and the plan he proposes for the attainment of his purpose is a very simple one. Almost normal to the coast line, and to the eastward, or windward, of the intended channel, will be built a breakwater extending out about 2,000 ft. to the 6-fathom curve. The purpose of this breakwater is to stop the sand from traveling to the west, and thus prevent it from blocking up the channel that he proposes to dredge within the jetty. The sand will accumulate on the windward side of the pier and in time may make an extension necessary; but this is a matter for the future and of comparatively small cost when demanded. The entrance channel proposed would have a depth of 30 ft. and a bottom width of 500 ft., and to break up the eddy that would result from the inward curl of the long wave passing across from the head of the pier to the west shore another short jetty is located west of the channel.

(To be continued.)



VIEW OF JETTY, LOOKING TOWARD INNER HARBOR, GREYTOWN, NICARAGUA.

To the left or windward side of the jetty is seen the sand that has accumulated since construction. The entrance to the canal is to the extreme right of the inner harbor

The Present Outlook for Manufactured Fuel Gas.*

DIFFERENT FUEL GASES COMPARED.

A gas to be of value for heating purposes must contain a sufficient amount of combustible to produce a good amount of heat, and be of such a quality as to produce a good combustion temperature. The gas having the greatest heating value, is the one in which the product of these factors is greatest.

The formula used for obtaining combustion temperatures of gases is

$$t = \frac{u}{w \times s} + h$$

Where t = temperature;
u = heat units;
w = weight of products of combustion;
s = specific heat of products of combustion;
h = heat added by the air.

For the present we will omit h.

If now we multiply both sides of the equation by u, we will have

$$ut = \frac{u^2}{ws}$$

This gives us that the fuel values of gases are relatively to each other as the square of their heat units divided by the product of the specific heat and the weight of the products of combustion. Comparing then the present manufactured fuel gases with natural gas as a base, we will have:

1,000 ft. of natural gas	=	1,300 ft.	coal gas.
1,000 ft. " "	=	1,700 ft.	water gas carbureted.
1,000 ft. " "	=	2,500 ft.	water gas.
1,000 ft. " "	=	8,500 ft.	producer gas.

These calculations are made without any estimate for excess of air. When we come to consider the combustion of these gases we find it absolutely necessary to use air considerably in excess of that actually required for such gases as natural gas, coal gas and carbureted water gas; and this excess in practice amounts to fully 50%. Fuel water gas, however, can be burned to perfect combustion with but little excess of air, 20% being ample. Estimating 50% excess of air for natural gas and 20% for water gas, they will stand as 2,000 : 2,100—a difference of nearly 20% in favor of water gas.

We have seen the relative values of the manufactured fuel gases with natural gas. Coal gas and carbureted water gas are good fuel gases, as they contain, volume for volume, the largest quantity of heat units, and their flame temperature is quite high.

Water gas, viz., hydrogen and carbonic oxide gases, are good fuel gases, as their combustion temperatures are very high, though the quantity of heat they contain is much less than the other two. Producer gas is for many manufacturing purposes a good fuel gas; but to be made available for domestic heating some plan for reheating the gas before combustion must be devised, and so far as I am aware this has not at present been practically accomplished. We are then reduced to three gases available for domestic heating: Coal gas, carbureted water gas and water gas; the first two apparently leading in value, but plain water gas is a very good second.

The materials in nature that are cheap to-day, and that can be depended upon to remain so, and from which we can make our gas, are two in number, soft coal and crude oil; and we can go still farther and safely say that all processes before the public using other than soft coal for a basis of fuel gas manufacture are valuable only on a small scale and are not practical for large operations. This statement may seem absurd to many who are enthusiastic over crude oil gas for fuel. If they will but figure the amount of gas in one gallon of crude oil, its heating value, the extent of the production of our oil fields, the amount required for illuminating purposes to be deducted from this production, and then estimate the oil requirements for fuel gas to supply only one of the largest cities in our state, they will see their error.

From the most reliable statements that can be obtained from those interested in the manufacture of gas for fuel purposes, I find that 1 ton of 2,000 lbs. of an average qual

*Condensed from a paper by Mr. GEO. H. CHRISTIAN, Jr. read before the Ohio Association of Gas Engineers.

ity of soft coal will produce 45,000 ft. of gas, containing 16,200,000 H. U., or 360 H. U. per ft. Assuming the carbon in the coal to weigh 1,750 lbs., and estimating 14,500 H. U., we have a total of 25,375,000 units. This shows the process to have an efficiency of 64%.

In carbureted water gas, allowing the same per cent. of ash as in the former case, efficiencies as high as 70% can be obtained. In coal gas manufacture proper it is quite difficult to determine efficiencies, as the residuals that remain are largely only valuable as they themselves can be converted into gas through the medium of a water gas process. By combining coal gas and water gas 33,000 ft. of a gas containing 400 H. U. per ft. can be had, showing an efficiency of 60%.

We find, then, carbureted water gas leading in efficiency of manufacture, water gas second, and coal and water gas third.

The amount of labor and repair cost varies considerably in different localities. I have endeavored to obtain an average cost for the various gases as obtains in daily practice:

	Cents.
Labor and repairs cost, coal gas	13
" " coal and water gas	7½
" " carbureted water gas	6
" " water gas	5

These figures are based on continuous running. Estimating this cost on basis of heat units in each gas, and they stand:

	Cents.
Labor and repairs cost, coal gas	13
" " " coal and water gas	10
" " " carbureted water gas	6
" " " water gas	9½
" " " coal and carbureted water gas.	8

Here carbureted water gas gives lowest labor cost.

When we come to consider distribution cost, it needs but little argument to convince you that coal gas ranks first. The cost for street mains and holders for storage form two of the largest items in total cost for fuel gas plant meters and service connections swell that cost materially. To maintain low capital cost must be the aim of all fuel gas engineers. This cannot be accomplished if we must use the maximum sizes of mains, services, meters and holders to handle the very much larger volumes of gas required to do the work when using a gas of low heating value. The experiences of the natural gas companies show what difficulties are met with in distributing gas, owing to the varying demands. How much greater these difficulties when storage is necessary to meet these demands!

EFFICIENCY OF SOLID AND GASEOUS FUEL.

We now come to consider results obtained in practice in the combustion of fuels, and will first take solid fuel as used under boilers. I will take an example of two boilers running steadily for six months with nut coal. They gave an evaporation of 8½ lbs. of water from and at 212°, or nearly 55% efficiency. Natural gas was afterward burned under these boilers for four months, and it required 18,000 ft. of gas to equal one ton of coal, or an efficiency of 80% for the gas. This efficiency was no doubt increased by using heated air to mix with the gas.

Coal as used in domestic heating gives far different results. Of one ton of hard coal burned in a base burner stove, 25% will be returned as ash, a large per cent. of the remainder of the fuel will be burned only to carbonic monoxide. If the whole product were carbonic monoxide, we would have a two-thirds loss, and utilize but 27% of the total heat of the fuel generated. Allowing one-fourth of the fuel remaining to be burned to carbon dioxide, which would be a fair average for the 24 hours of heating, and we will have but 33% generated. Now, in our best arranged stoves we utilize about 70% of the heat generated; hence the total efficiency of solid fuel burned for domestic purposes is 23%. This seems, indeed, a very poor showing for solid fuel; and yet I think if I err it will be on the side of estimating it too high. We find in practice that it requires 20,000 ft. of natural gas to equal one ton of hard coal for domestic heating. Thus 20,000,000 heat units are consumed to obtain 6,700,000 units in useful effect, showing only 33% total efficiency in natural gas combustion. Where is this loss? Surely the heat utilized compared with that generated is fully as great as obtains in solid fuel combustion, so the loss here is in the failure to generate, with any reasonable degree of efficiency, the heat in the gas. There can be no doubt as to the difficulty, in practice, of obtaining perfect combustion from those gases containing large volumes of hydrocarbon gases. A previous admixture of air is required to prevent smoke, and it is also supposed to be necessary to admit air in excess to insure perfect combustion. My experience is not in accord with this view, as I will show you.

The author then described experiments with gas stoves burning carbureted water gas which showed that no excess of air mixed with the gas before its burning would suffice to produce perfect combustion. Success was finally obtained, however, by admitting air in small streams to mix with the carbonic oxide produced by the first combustion.

This method of burning gas is different from that which obtains in general practice in heating stoves; and I am thoroughly convinced that we lose large quantities of heat by the ordinary methods. We find the best authorities on solid fuel combustion advocating this principle, namely, admitting air through small orifices above the fuel bed. Professor DANIELL says: "There can be no doubt that the affinity of hydrogen for oxygen is stronger than that of carbon, and that in the combustion of the different forms of hydrocarbon it is well known that the whole of the carbon is never combined with oxygen in the process of combustion unless a large excess of oxygen be present; furthermore, in burning coke, or when coal has been burned down to a clear, red fire on the grate bars, although the combustion on the grate may appear perfect, and no flame or smoke may be produced, there is a large amount of useful heat lost owing to the formation of carbonic oxide, which, not finding a fresh supply of air at a proper place, necessarily passes off unconsumed." In further experiment he determined that the best and only place to introduce air to a furnace is at the furnace door or behind the bridge wall, and not under and through the fuel bed; and that the combustion produced in this way gave an increase in temperature in the flues of the boiler of over 400°, showing conclusively the combustion of the oxide to acid. This air, however, should be admitted in innumerable little jets by passing the same through thin or small orifices in the furnace door; any opening of the door itself and allowing of the air to pass in in mass will have the contrary effect, and rob the fire of effective heat.

The waste that is had in natural gas combustion for domestic use is altogether too great, and such general waste in manufactured gas would ruin the business. There are those engaged in the manufacture of heating and cooking stoves who assure us of 85% utilization of the heat generated; generating, then, but 60%, we would have one-half of the heat in useful effect, or 14,000 ft. of natural gas equaling one ton of coal.

Water gas for practical use has a great advantage over other gas fuels, in that perfect combustion must take place and its full equivalent of heat be generated. We thus obtain in its use total efficiencies equaling 70%. We have no reason for doubting statements made for this gas that 20,000 ft. will equal one ton of hard coal for domestic heating.

PRICES AT WHICH FUEL GAS MAY BE SOLD.

The consumer holds the position of demand, the manufacturer that of supply, and as in most commercial affairs the demand regulates the price, so will it in this business. Prices for illuminating gas in the past have ruled higher in this country than they would had competition been sharper. This is evidenced from the fact that most gas companies have established two prices for the same product—the rate for cooking very materially less than that for illumination. This lower rate was made to meet the ruling prices of other fuels. This branch of the business has become very extensive, and is increasing quite as rapidly as the main business. The average ruling price for gas for heating and cooking has been $1 per 1,000 ft. At this price gas has proven to be fully as economical a summer fuel as any other possessing the same degree of convenience and comfort for the housekeeper; but for any general heating this rate will be found to be entirely too expensive.

The advent and very general use of natural gas wherever obtainable, has proven its very great convenience and comfort, and to-day we find the public clamorous for gaseous fuel. The people are ready for the change and willing to meet the necessary expense connected with adopting the same, provided they can be assured that the cost for heating will not be, to any marked degree, greater than by solid fuel. In the early days of natural gas distribution, to introduce the new fuel very generally and rapidly, the companies contracted to do heating and cooking for a certain lump sum per month per stove. They soon found this method very conducive to great waste of the fuel, and they abandoned it and went back to the metering of the gas. The present illuminating gas companies cannot afford to do heating for a lump sum per month, even for a short time, to thereby more generally introduce gas as a fuel; they must, however, recognize this growing demand for agas fuel, and reduce the price of their illuminating gas for heating purposes until they reach a figure that will give general satisfaction to their patrons, and guarantee to the company a rapid and large increase in business. It is better thus to establish a sales value for your product, than by either keeping the price too high, or reducing it too low, to suffer loss.

Theory and practice were born to disagree. We can calculate the efficiencies of gas and solid fuel heating, and the efficiencies of gas manufacture, and from these deduce the sales value of our product; but practice determines differently. The many economical devices too frequently prove, in general practice, useless; and it is not alone the quantity needed to do the work, but also that which can be wasted that governs the cost of an article; and this trebly so in this field, where waste is so easily had. To the prevention of this waste, much energy must be devoted and the methods of burning gas economically must be more generally tanght.

The use of natural gas has given a great impetus to the demands by the people for fuel gas, yet the experience had in the burning of natural gas by the very wasteful method now employed, will hinder rather than advance their chances for obtaining the manufactured article.

Finally, we must view our subject from the standpoint of profit and loss, and see what must be done to make this business a commercial success. On account of the large amount of capital invested in the illuminating gas business, it devolves upon these companies to utilize their present plants to convey gas for fuel as well as light, and they must take the initiative in this movement. Let the manufacturers of coal gas and carbureted water gas combined calculate the cost of their gas in the holder per 1,000 ft. for material, labor and repairs, in any section where gas coal can be had for $3 per ton, and Lima naphtha for 3 cts. per gall. The gas made will be 19-candle value and contain 750,000 H. U. I believe I do not err when I say that the present cost for distribution, interest, taxes, etc., does not exceed the cost of gas in the holder, in any works the bonded debt of which is not excessive; and it should be remembered that by doubling the amount of gas sold you should reduce distribution cost more than one-third. Each company could thus determine for itself whether it could not well afford to enter the fuel gas field by establishing a very low rate for gas used for fuel purposes; and I think that that rate would be found to be very much lower than has heretofore been generally considered advisable or possible.

Natural gas companies are selling gas for 15 cts. per 1,000 ft. Interest, taxes, distribution, improvements and repairs must amount to six or seven cents per 1,000 ft., leaving them a profit of from eight to nine cents. This sum has been ample to pay large dividends and set aside a surplus. Allowing 10 cts. per 1,000 ft. profit to illuminating gas companies on their sales of gas for fuel purposes, at what rate can they afford to sell such gas?

Suppose, for the sake of an example, that some company should be so favorably situated as to feel warranted in making this rate 50 cts. per 1,000 ft. Can the consumer afford to pay this price for gas for heating and cooking? Natural gas, as now wastefully burned, is, at 15 cts. per 1,000 ft., equal in price to hard coal at $3 per net ton. When we can burn coal gas with a total efficiency of 65%, 15,000 ft. of it will do as much heating as 20,000 ft. of natural gas now does. Coal gas, then, at 50 cts. per 1,000 ft. would equal hard coal at $7.50 per net ton. This is so little in excess of the cost of hard coal fuel, when we consider the cost of removing the ashes and dirt, that I believe its general use as a fuel at that price could be assured.

That a combined fuel and illuminating gas plant can be made a successful business venture cannot be doubted. The plant at Jackson, Mich., was started some three years ago, at a time when all previous attempts in this direction had proven failures. To-day this plant is in successful operation, and doing a larger business than in any previous year. The fact of those financially interested in the Jackson plant having advanced money to build and operate a similar plant on a far larger scale, should be proof sufficient even to the most skeptical that fuel gas can be made a success.

Legal Decisions of Interest to Engineers.

Right of Way on Railway Crossing.—A railroad company which has allowed another company to cross its land which was neither acquired nor used by it for any public use, cannot afterward enjoin the latter company from laying a side track on said land within the limits of its right of way. (Chicago, St. L. & P. Ry. Co. v. Cincinnati, W. & M. Ry. Co., Sup. Ct. of Ind., 26 N. E. Rep., 204.)

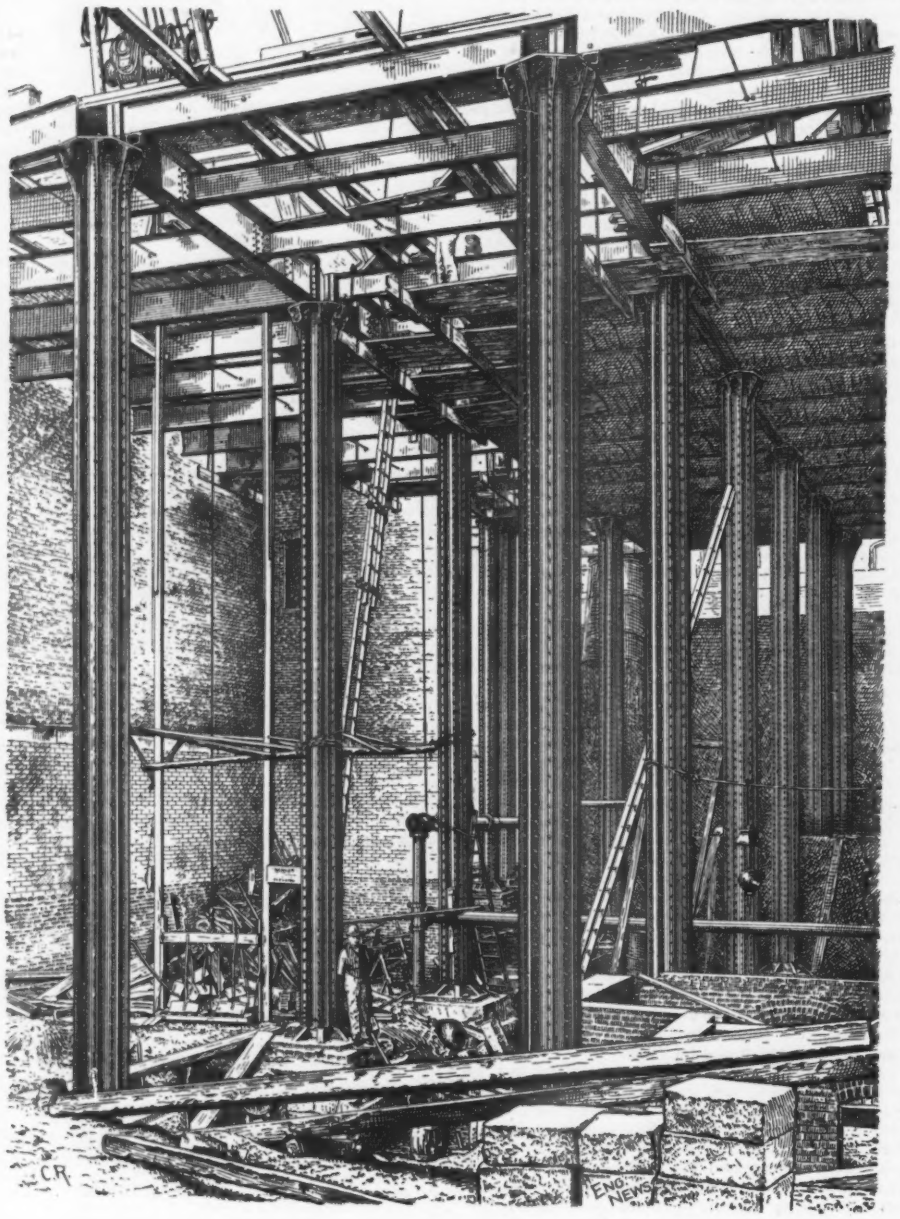
Discrimination in Exclusive Depot Privileges.—Independently of, as well as under Michigan Statutes, Sec. 3355, providing that "all railroad corporations shall grant equal facilities for the transportation of passengers and freights to all persons, companies, or corporations," railroad company cannot grant to a hack and bus company exclusive, or even better, facilities for delivering and receiving passengers to and from the depot than that allowed others in the same business. (Kalamazoo Hack & Bus Co., Lim., v. Sootsma, Supr. Ct., Mich., 47 N. W. Rep. 637.)

Construction of Grant to Water Company.—An act of the Legislature authorizing the common council of a municipality to grant the right to any private corporation to supply water to its inhabitants and to lay water pipes and mains through and under the streets, authorizes a contract with a corporation organized to supply the village and the inhabitants of the vicinity and village with water, to lay mains in the streets, through which, in addition to supplying said village and its inhabitants, the corporation might supply the inhabitants of the vicinity outside the village with water. (City of Duluth v. Dul. Gas & Water Co., Sup. Ct. Minn., 47 N. W. Rep., 781.)

Fraudulent Railway Construction Contract and Lease.—In order to construct a connecting line for a railway company a new company was organized, some of the directors and incorporators being directors of the old company. The new company made an agreement for the construction of its road, whereby it was to issue to the contractor $1,000,000 of 7 per cent. bonds and $500,000 of capital stock, being all the bonds and stock of the company. The contractor was a mere figurehead, representing a syndicate of the directors, and assigned both the securities and the contract to them. The actual cost of constructing the road was $850,000, and after the completion it was leased to the old company, which agreed to pay a rental equal to 30 per cent. of the new road's gross earnings, and guaranteed that such sum should never be less than $105,000 per annum, or 7 per cent. on the total issue of bonds and stock. While the lease was made in pursuance of a corrupt scheme to impose upon the old company an obligation for the benefit of some of its own directors, yet it was merely voidable, and not void, and if legally ratified became binding upon the old company.—(Barr v. N. Y., L. E. & W. Ry. Co., Ct. App. N. Y., 26 N. E. Rep., 145.)

High Unbraced Wrought-Iron Columns.

We present herewith an illustration of an interesting example of the newest and best modern column practice in large buildings. The growing use and necessity for columns, sometimes long ones, carrying loads hitherto considered as extravagant or visionary has lately become a matter of general note. We have already commented upon the demand for more reliable material than cast iron for such columns, which shall yet be economical, and the attempt to compel by legislation the return to the old practice and the inferior material.



PHŒNIX COLUMNS IN EDISON ELECTRIC ILLUMINATING CO.'S NEW CENTRAL STATION, NEW YORK CITY.

Our illustration is from a photograph recently taken of the new central lighting station of the Edison Electric Illuminating Co. at the southeast corner of Elm and Pearl Sts., New York, the plans for which were prepared by Messrs. Buckman & Deisler, the company's architects, who have recently completed two other stations for the same company in this city. In this building several essentially novel features of planning and of arrangements for economy in operation have been embodied which entailed the carrying of some very considerable loads on columns unsupported for a notable length, the loading considered. The total loads, dead and live, on these columns were computed as slightly less than 600 net tons, and this loading was assumed in the calculations. The length of the columns from the top of the base stone to the bottom of the girders was 35 ft. 4 ins. The original intention of the architects was to finish in the first tier temporarily, the remainder of the building to be carried up later on in the same construction, and the details of the construction were to be got out with this in view. The present building is 75×110 ft., constituting the lower portion of the lighting station proper, and will be 8 stories in height. It is so arranged and calculated that it may be extended back in the direction of its length about 80 ft. more, and an additional frontage of 25 ft. built out to Elm St. the full depth of the building, this part being used for offices, and then the whole structure carried up to 12 stories in height (or about 185 ft.), making it when completed a noteworthy addition to the city's large structures.

The architects submitted the question of the practicability of manufacture of the requisite columns and the matter of their design to Messrs. Milliken Bros., of New York, the agents of the Phœnix Iron Co., desiring them also to arrange in advance for the manufacture of these columns after approval by them of the detailed shop drawings prepared by the contractors for the other part of the work.

The assumption of floor loading on this tier was 300 lbs. per sq. ft., including the weight of the construction. The layout of the beams and the riveted girders offer no points specially worthy of note except that the girders being taken as 26 ins. deep for economy and the floor beams being flush on top (or practically so), where the beams come opposite the column their lower flange is about 5 ins. above the level of the cap plate, the column joint being, of course, at the level of the bottom of the girder. This necessitated the use of cast-iron stools, or blocking pieces, through which these beams are bolted to cap plates. The middle bay beams are 15 ins., and are flush on bottom with the 20 ins., so no higher stool is needed in their case. All the floor beams have heavy wall anchors. They all frame into the girders, and the girders are heavily flange bolted to column cap plates. It was decided to use fillers between the flanges of the columns, not only for convenience in rolling the material, thereby reducing the weight of individual pieces, but also to allow of the insertion of ring plates, or "dovetails," at the heads of the columns. These triangular plates are welded to the filler bars, and form strong brackets supporting the cap plates. They are reinforced by angle iron knees, and coming under the bearings of beams and girders help support the cap plates of 1½-in. iron 38 ins. square, and carry these loads down well into the column itself.

The thickness of these filler bars was so adjusted that the two front columns, coming next the front wall, and having less load, are of practically the same outside appearance, while considerable section is taken out of the segments in thickness, and of the fillers in depth.

The columns are of the Phœnix pattern, and have a finished weight of over 15,000 lbs. each. The segments were calculated so that the piles from which they were rolled would barely go in the largest heating furnaces available. Cast-iron tennon bases, through-bolted to column, were adopted for reasons affecting economy in manufacture, time of delivery and convenience in shipping and setting. There are 14 columns, arranged in two rows of 6 each, spaced 20 ft. c. to c. for the length of the building and 18 ft. c. to c. for its width, the latter leaving 23 ft. 8 ins. from the center of the column to the wall. The plate girders run lengthwise of the building, and the iron and steel I-beams are spaced 6 ft. 8 ins. c. to c. The two other columns are at one side of the building for a special arrangement of the beams. The columns are of wrought iron. The waste of steel blooms in the heating surface would have been considerably greater, and there were other reasons connected with the manufacture of the columns for which it was considered more advisable to use wrought-iron segments.

In calculating the section, no distinction was made between the safety factor for static or for live load. Owing to the extreme conditions to be met, to the probability of more or less constant vibration from the nature of the plant, and to the possibility of accidental side blows to the columns in moving machinery or boilers about, it was deemed best to adopt a uniform safety factor of 4 for all loads, taking the full assumption from the roof down. This was further slightly increased by disregarding the very appreciable increment to the least radius of gyration caused by the employment of 8 filler bars, approximately $\frac{13}{16}$ in. thick. In other words, the well-known formula, $\frac{P}{S} = \frac{42{,}000}{1 + \left(\frac{1}{50{,}000} \times \frac{l^2}{r^2}\right)}$, for crushing strain per square inch, deduced from the Watertown experiments, was used, in which the least radius was taken as that of a column of the approximate thickness required, and without fillers.

The column joint being below the girder, provision had to be made for connecting the next tier of columns after the first floor was on and arched in. The so-called "G" Phœnix columns (which were those used, as shown) have eight segments. Four sectors of the circumference were appropriated by flange bolts for the two beams and two riveted girders coming in at right angles. In the other four (being alternate divisions with those already mentioned) open holes were left, and on the bottom of the column above a ¾-in. plate, cut out in the shape of a Maltese cross, is riveted through knees on the shelf. The notches in this cross allow the base plate to slip down between the ends of the beams and girders resting on the cap-plate of the lower column, and open holes in the arms of this plate-iron cross match these above mentioned. All the columns are faced after the gusset plates and knees are riveted on in a plane at right angles to their axes, and the cap and base plates are planed on both sides before being riveted to the knees with countersunk rivets. It is not in-

tended to use base plates on the upper columns as the building goes up, except where a reduction in the diameter of the columns takes place, or where columns are of unusual length, the ordinary practice of bolting through wrought-iron knees being considered amply secure.

Notwithstanding the somewhat unusual character of the demand, yet owing to the contractors being allowed about four weeks' time in advance, the 14 columns were ready for delivery the day the architects called for them, and owing to the facilities and care employed by the Jackson Architectural Iron Works who set the work in place, they were enabled to accomplish the erection of the 14 columns and the first tier of beams and girders in seven days' time, which was very prompt work.

Mr. MILLIKEN makes the interesting calculation, figuring by the well-known Rankine's modification of Gordon's formula, with the usual values for a and f, with a safety factor of 8, that a cast-iron column of the same diameter as the effective diameter of the Phœnix columns used would not be sufficient to carry the load, even if the columns were cast solid. Without having checked the calculation, it can be seen by mere inspection of this drawing that it must be substantially true.

Mountain Railway Construction.*

Although the fallacy of the narrow-gage arguments advanced so vehemently a few years ago is now generally understood, still railway men generally do not appreciate the fact that the same results in the way of light construction, sharp curves, and heavy grades can be obtained with a standard gage railway almost as well with a narrow gage, and without the attending disadvantages. To illustrate this the author presented a description of some extensions that were added to a system of lumber railways in northwestern Pennsylvania, under his direction, during the past year. This system, which will aggregate about 70 miles, is intended to develop the fine hemlock forests of that region. Topographically the country is much broken, being intersected by a number of small streams, from which the hills rise abruptly. It became necessary, therefore, that each principal valley should have a line of railway with tram-road feeders from the several mills located on the branches. A rather large mileage for the territory to be served was therefore required, on which account it was necessary to keep the expense of construction as low as possible. The heavy timbering and hardness of the material to be moved were constant obstacles to cheap work, while the ruling grade in each case was rendered so very steep by the elevations to be overcome in short distances that no breaking of grade line was permissible, and therefore heavy work in rough places could be avoided or lightened only by the introduction of sharp reversed curves.

One of the main stems was 7 miles long, running up a valley, crossing the summit, and then down a stream on the other side. From the bottom, where connection was made with an existing track, to the summit was 8.64 miles, with difference in elevation of 606 ft. A compensation of 0.03 was decided on, so that the grades on tangents worked out to be 3.316%, or 175 ft. per mile. This grade was in favor of traffic, but on the other side of the divide the country was quite similar, so that a grade of 3.12% compensated had to be used there against the loads. The limit of curvature was put at 18°, although one curve of 19° was laid out. As speed would be low, super-elevation could be kept down, and therefore a minimum length of tangent of 100 ft. permitted, although the shortest tangent was 77.1 ft. between 18° curves.

Surveying was slow and expensive owing to the heavy timber. The difference of levels between summit and starting points was determined as closely as possible in the usual manner by aneroids, and then a trial preliminary run. It was afterwards found much more expeditious to equip the chief of party with a light tripod-mounted compass, provided with a telescope carrying a long bubble tube and vertical circle. By setting the circle at the grade angle he laid out the preliminary in advance of the party, so that the axemen could clear the ground. The line as thus staked closely approximated the actual grade line. Topography was accurately taken, plotted on a scale of 200 ft. per inch, with 5-ft. contours (or 100 ft. per inch in rough places), the line of grade projected, and the railway line fitted as closely to this as 18° curves would allow. On running this line in the field the changes required were but slight. In a heavily timbered country, and where cost of work must be closely watched, the method of "paper" location is in comparably superior to field location, which, under such conditions, at least, is little better than a good guess. The cost of engineering for location and construction, including running complete preliminaries on two different routes, was about $400 per mile, a large portion of which was due to the number of axemen rendered necessary.

Cuts were made 16 ft. wide, and fills 12 ft. The whole of the work being on side hill, which in many places was very steep, and in a wet country, much water had to be dealt with. Cross drain-boxes were used freely. Culverts under 4-ft. banks were single or double wooden boxes 12 × 24 ins.; under 10 ft. banks log culverts were adopted; while under banks over 10 ft. dry rubble culverts 2 × 3 ft., single or double, were built. There were on the 7 miles of the line 75,271 cu. yds. of material moved, of which 5,633 cu. yds., or 7.6% were solid rock; 8,298 cu. yds., or 11% loose rock; 26,468 cu. yds., or 35.2% tough clay, where 6 picks were required for 5 shovels, and 34,872 cu. yds., or 46.2% earth, most of which was heavy soil. The actual cost of labor, explosives and tools, including also feed and care of horses and mules, for grading was $35,938, from which there is to be deducted a credit of $750 for value of tools left on hand, so that the net actual cost was $35,188. This covered grubbing and clearing 51 acres; all the earthwork, including slope ditches, 467 cu. yds. dry culvert masonry, 68 wooden box and log culverts and 2,424 ft. of hemlock lumber for drain boxes, in fact everything complete, ready for track, except trestles. This is an average of $5,026 per mile, or 46½ cts. per cu. yd. of earthwork, without regard for classification, including, however, the cost of the sundry extras mentioned above, while the great percentage of rock and hardpan is to be borne in mind. The right of way was 50 ft. wide, and, as the fills and cuts were light, the proportion to be grubbed was great. This work, under such conditions, cost between $50 and $60 per acre.

In light work of this character, especially where timbered so that roots interfere with continuous borrowing, and where soil is heavy, there is great danger of underestimating cost of grading. A generous allowance should be made to ordinarily prevailing contract figures.

The only available wood for trestles was hemlock, which cost from $7.50 to $8 per 1,000 ft. Large sticks were easily procured, and on account of this and the low price it was possible to have the dimensions of the stringers greater than usual with pine, in order to allow for the unreliability of hemlock. Posts and sills, 12 × 12 ins.; caps, 12 × 12 and 12 × 14 ins.; stringers were single sticks, 12 × 18 ins. Bents were set 12 ft. c. to c., standing on mudsills, and stayed laterally and longitudinally by 12 × 2 in. plank bracing. All members were secured by drift bolts. There were 102,258 ft. B. M. of hemlock used of which 13,704 ft. were hewn from trees adjacent to track. The sills and mudsills were generally made from this latter. About 1⅛ ft. B. M. timber were used for each cu. yd. of earthwork. The cost of labor per 1,000 ft. framing and erecting was $9.53, which included expense of felling and hewing 1,142 lin. ft. of timber. The cost of bolts and spikes was 12 cts. per lin. ft. of trestle. The average cost of trestles per mile of road, varying in height up to 28 ft., was as follows:

12,650 ft. B. M., at $7.75	$98.04
163 lin. ft. hewn timber. No charge	.....
Bolts, spikes, etc.	13.20
Labor, hewing, framing, erecting	130.21
Total per mile	$250.45

The gage of the track was 4 ft. 8½ ins.; rails, 40 lbs. per yd., with supported and broken joints spliced with single bars; the ties were of hemlock, usual size, spaced 17 to a rail length. Split switches were used, with automatic switch stands, using the low-target pattern, with weighted ground lever as the automatic device. The cost of 1 mile of such track was as follows, on last year's prices:

62.86 tons rails, at $33	$2,074.38
352 joints complete, at $0.55	193.60
6,200 lbs. spikes, at $0.225	139.50
3,000 crossties, at $0.15	450.00
Freight on materials	159.00
Tracklaying	400.00
Total	$3,416.48

The average cost per mile of the most expensive section on this line was as follows:

Grading	$5,026.89
Trestles	250.45
Track	3,416.48
Engineering	400.00
Total	$9,093.82

On other lines where topography was easier the cost of grading was lightened, so that total cost per mile was reduced to about $6,500. These limits of cost furnished a railway standard in all respects, except as to unusual alinement and lightness of track. With a limit of curvature of 10° or even 12°, the building of these lines would not have been feasible.

The switchback method of line development was used. One switchback was constructed on a grade of 3.746% against traffic, and two more are laid out on projected lines. Switchbacks for lumber roads have one great advantage, that they can generally be laid out near the head of the valley, with the effect of throwing the line down into the valley bottom, so that timber can come down to the road. They also serve as safety switches on steep grades.

The motive power consisted of 4 locomotives; 3 being Shay-geared engines, and the other an ordinary mogul. The Shay engines have three inverted cylinders set vertically and together on one side of the boiler, just ahead of the cab, driving a shaft which runs the whole length of the engine and tender, and is geared by bevel gearing to every wheel. Between each pair of wheels is an articulated joint in the shaft, so that the length of rigid wheel base is that of an ordinary truck. The great advantages are sound wheel base and high piston speed, and that the whole weight of engine and tender is utilized for traction, and distributed over a much greater length of track than is the tractive weight of an ordinary locomotive. These engines are therefore adapted to slow speeds, steep grades and sharp curves. The disadvantages are the enforced low speed and those disadvantages attending such mechanical devices. [These engines were described and illustrated in ENGINEERING NEWS, April 26, 1890.—ED.]

The dimensions of the 3 Shay engines were as follows, all having 3 cylinders:

Weight.	Cylinders.	Driving-wheels.
120,000 lbs.	14 × 12 in.	12, 32 in. diameter
56,000 "	10 × 10 "	8, 28 "
70,000 "	11 × 10 "	8, 29½ "

The mogul engine weighs 70,300 lbs.; the weight on the drivers is 61,200 lbs.; the driving-wheels are 4 ft. diam.; the rigid wheel base is 10 ft.; the cylinders are 15 × 24 ins. This engine is in constant service and finds no difficulty in working around the sharp curves, showing that a special form of engine is not necessary for such alinement as described. As a proof of this, and to show what strain a light track if built with care can resist, the mogul engine with 7 loaded cars of lumber started down the 3.316% grade. The brakes were defective and the train passed beyond the trainmen's control, running down the hill 3½ miles, and through the reverse curves without damage to themselves or track. On passing the junction of the new track with the old line the combination of a flat curve out of line and a sag in the grade threw one car off the rails, when all the cars capsized, the engine, however, remaining on the track.

The author does not advocate the use of sharp curves or light rails, but cites the construction and operation of this road to show that under proper restrictions sharper curves and lighter rails can be used than is generally supposed, and so render possible the construction of railways that would not be feasible if the ordinary limits of curvature and superstructure were enforced. Speed is much more destructive to track than weight, and the constantly increasing weight of rails is rendered necessary more by the increase in speed of trains than by that in the weight of the locomotives. If speeds are kept low a light weight of rail will be found serviceable.

In the construction of such railways, as much engineering skill will be required as in the building of more pretentious lines, and even more. Every foot of the alinement must be carefully studied and every item of expenditure rigidly considered, so that the construction becomes a connected series of small detail problems.

* Abstract of a paper by Mr. WM. B. PARSONS, presented at the annual convention of the American Society of Civil Engineers.

PERSONALS.

Mr. FRANK W. PATTERSON, of Pittsburg, P., has been elected City Engineer of McKeesport, Pa.

Mr. SAMUEL E. TODD, a sewer pipe inventor and manufacturer, died recently at Bridgeport, Conn., at the age of 63 years.

Mr. ALEXANDER SWIFT, formerly of the Swift Iron & Steel Works, Newport, Ky., died April 23 at his home in Cincinnati, O.

Mr. JOHN W. HOBERT, General Manager of the Central Vermont R. R. Co., has resigned his position, his resignation to take effect June 1.

Mr. WM. H. BAKER has been appointed Chief Engineer of the Corpus Christi & South American Ry. Co., with offices at Corpus Christi, Tex.

Mr. W. J. FINNEY, of Atlanta, Ga., Assistant Engineer of the Monterey & Mexican Gulf Ry., died at Tampico, Mex., May 7, of typhoid fever.

Mr. R. F. HARTFORD, of Hartford, Herbert & Co., of Chattanooga, Tenn., has been appointed Consulting Engineer for the Springfield, Mo., sewerage system.

Mr. WALTER GRAVES, of Denver, Col., has been appointed Chief Engineer of the irrigation works to be established on the Crow Indian Reservation in Montana.

Mr. HENRY M. HOWE, of Boston, Mass., has been awarded a prize of 2,500 francs by the Société d'Encouragement pour l'Industrie Nationale, of Paris, for his treatise on The Metallurgy of Steel.

Mr. A. M. WELLINGTON sailed for Europe with his family by S. S. *Friesland*, to be absent during the summer. He expects to return by S. S. *City of Paris*, sailing from Liverpool Sept. 30. His address will be, care of Brown, Shipley & Co., London, England.

Mr. HERBERT M. WILSON, M. Am. Soc. C. E., also of the U. S. Geological Survey, has been appointed Consulting Engineer by the Secretary of the Interior to make examinations and report on some large irrigation projects

in California and Nevada which have been recommended by the various Indian agents in these states.

Mr. E. L. CORTHELL, M. Am. Soc. C. E., sailed for Europe on May 30. He will visit and examine docks and harbors in England, France and at other points; and as Chairman of the Executive Committee of the International Congress of Engineers of the World's Fair, will advance the interests of that congress abroad.

Mr. WILLIAM COLE, a prominent contractor, died recently in Allston, Mass., at the age of 65. He was a native of North Yarmouth, Me. Mr. Cole's last business enterprise was the building of sewers in Wilmington, Del. He has been associated as contractor with waterworks in Lawrence, Lowell, Peabody and Gloucester, Mass.; Newport, R. I., and Newburyport, Mass.

Mr. ROBERT E. MCMATH, late Sewer Commissioner of St. Loui has opened an office as Consulting Engineer, making specialty of drainage, sewerage, sewage disposal, municipal engineering and river and harbor work. The style of the firm is Robert E. McMath & Sons, and its offices are in the Odd-Fellows Building, Ninth and Olive Sts., St. Louis.

Mr. S. C. ELLIS, late assistant city surveyor, of Boston, has been appointed engineer of the new board of surveys of that city, of which Hon. HUGH O'BRIEN is the chairman. This new board is to at once begin the work of platting streets in the outlying sections of the city, and is to act in conjunction with the city engineer, city surveyor and the superintendent of streets of Boston.

Mr. MANSFIELD MERRIMAN, Professor of Civil Engineering in Lehigh University, was married, on May 26, to Miss ANNA ROSINA GODSHALK, lately teacher in the Moravian Parochial School at Bethlehem, Pa. The civil engineers and architects of the class of '91 of the University presented a handsome silver service. Mr. and Mrs. MERRIMAN sailed on La Bretagne from New York on May 30, and will be absent in Europe until September next.

Mr. JAMES MCHENRY, prominent for his railway interests, died lately at London, England. Mr. MCHENRY first became prominent in the United States as the chief promoter of the Atlantic & Great Western R. R., and in 1872 vigorously opposed the administration of JAY GOULD as President of the Erie R. R., and JAMES FISK, Jr., DANIEL DREW and CORNELIUS VANDERBILT were also at times opposed to him. After a bitter struggle and by the aid of the foreign stockholders of the Erie Mr. MCHENRY finally forced Mr. GOULD and his associates to retire. Mr. MCHENRY is reported to have been a firm friend of Queen ISABELLA of Spain, and to have expended large sums of money in placing King ALPHONSO upon the Spanish throne. He commenced a similar movement for the benefit of the French Prince Imperial. He was originally from Philadelphia, Pa.; and his sister, the late Mrs. BELLEANGE COX, was long prominent in that city in all woman's work.

NEW PUBLICATIONS.

—*Examinations by the State Board of Health of the Water Supplies and Inland Waters of Massachusetts.* 1887-1890. *Part I. of Report on Water Supply and Sewerage.* Prepared and published by the Board. 1890. Large 8vo, pp. 857, including a very full index of 52 pp.; diagrams and two large colored folding maps.

Massachusetts ranks first among American states in the work done by its Board of Health. It is possible for the Board to maintain this rank because of the authority and support given it by the people through their legislators. That these statements are authorized will be evident to any one who is familiar with the work of the Board during the last few years in investigating the water supply and sewerage of the state under the authority of the "Act to Protect the Purity of Inland Waters," passed by the Legislature in 1888. The result of these investigations, or of those relating to water supply, are given in the volume under review, which is the first part of the full report.

In the first section of this volume the water-works systems of the state, 135 in number, including some which supply public institutions, are briefly described, and chemical and biological examinations of present sources of water supply and of other inland waters are presented. The examinations cover a period of two years. The 18 principal river basins of the state are next described, and the results of chemical and microscopical examinations are given. The methods employed in collecting the samples and making the analyses are described by Prof. T. M. DROWN, of the Massachusetts Institute of Technology, chemist of the Board. The third section consists of the report of Biologist G. H. PARKER on the organisms, excepting the bacteria, found in the waters of the State, July, 1887, to June, 1889.

Mr. F. B. STEARNS, engineer of the Board, summarizes the water-supply statistics already referred to, gives records of rainfall, flow of streams and temperature of air and water. The drinking waters of the state are next classified by Mr. H. F. MILLS, chairman of the committee of the Board under whose direction the examination were made. The classification is based upon the past or present pollution by sewage, or freedom from such pollution. By this study it has been found that nearly one-half of all the water supplies of the state have not been polluted by sewage.

Special topics relating to the quality of public water supplies, such as the effect of storage and the natural filtration of water, are discussed by Messrs. STEARNS and DROWN, and the latter also discusses the pollution and self-purification of streams.

One of the maps shows the river basins of the state and the places where samples of water have been taken for analysis. The other map shows the ratio of normal chlorine in different parts of the state, beginning with relatively high ratios at the seaboard and diminishing toward the west. The excess of chlorine above the normal ratio is an index of the present or past pollution of the waters. In this map the normal amounts of chlorine for various localities are shown by isochloral lines in red. Figures for different localities show whether the waters at such points have more or less than the normal amount of chlorine and thus the degree of pollution. Figures underlined indicate surface waters, and those not underlined ground waters.

Some of the more important points brought out by the chemists in their study, as presented in the introduction, are the following:

The distinction between normal and polluted waters; the chemical evidence of pollution in waters; normal chlorine; the idea of permanance, and of various degrees of susceptibility to decay in organic matter in water; the absence of dissolved oxygen and the putrefactive changes of organic matter in some waters at considerable depths; the effect of growing plants in obliterating evidences of decay; the chemical evidence of bacterial action in the state of change of organic matter; the essential differences in character of surface and ground waters which influence the interpretation of analyses; the influence of the season of the year on the composition of surface waters.

The wide scope of the investigations made and reported on is evident from the outline given above. The work has been minutely and faithfully done, as would be expected from seeing the names of those connected with it, and will prove of great service not only to the people of Massachusetts but to those of the whole country, and also, we make bold to add, to the civilized world.

—*Fifth Annual Report of the Factory Inspectors of the State of New York.* Transmitted to the Legislature January 26, 1891. Albany, James B. Lyon. Cloth, 8vo. pp. 675.

Factory inspectors are generally associated with the endeavor to diminish the evils of the sweating system, and the present report is very outspoken on this subject. The following extract gives a good idea of the problem that confronts the state's officers:

Concerning the clothing "sweat-shops" which I have reason to know do not always conform to the 60-hour limit as a week's work, it is my opinion that in order to compel compliance on their part, it will be necessary to increase the present force of deputy inspectors. The business of these "sweaters" is carried on in out-of the way places, in bed-rooms and rear lofts, so that their workshops are difficult to enter and locate. When a visit is made to one of them, the "boss" and all hands take refuge in silence and shrugs of the shoulders and claim they do not understand what is being said, even by the interpreter. Nothing but constant espionage will bring this class of taskmasters to a realizing sense of the law. . . . It would, indeed, be bad enough if this condition of affairs continued for only 10 hours a day, but when it is the case for 14, 16 and even 18 hours a day, for six or seven days a week during a period of seven or eight months a year, the aggregate destruction to health cannot be estimated.

Summed up, the trouble with the "sweater" workshops of New York is this: The hours of labor are too long, being sometimes as high as 90 a week; the ventilating and sanitary arrangements are nearly always vile to the last degree, and the work-rooms are excessively overcrowded. The factory inspectors have no authority in these matters except as to the hours of labor of women under 21 and boys under 18 years of age, and in order to detect violations of the law in this respect, more men are needed as deputies. The law should also be amended, giving the inspectors authority to require a sufficient number of cubic feet of air space for each person in a work-room, and to require that proper means of ventilation should be supplied.

Some of the remarks on elevators are also worth quoting. After mentioning the difficulties of examining the elevator machinery in cellars and garrets where it is often located, the report states that steel hoisting ropes are often crystallized to such an extent that on bending them in a direction contrary to the curve they assume on the pulleys and drums, wires which originally seemed without a flaw will separate and sometimes whole strands snap. Well oiled iron rope is recommended. With regard to safety catches, the majority are said to be deficient for several reasons and the catch described in the third annual report is again recommended.

Attention is called to the danger of locating elevators near stairways, and it is stated that several of the greatest and most fatal fires in recent years may be attributed to such construction. The stairways wound around the elevator shafts, which acted as chimneys, and all access from the top floors to the ground was cut off. The report recommends encasing all shafts in brick walls, as is now required in New York and Brooklyn.

The volume is accompanied by a complete record of the work done by the inspectors and their deputies during the past year and a list of the accidents reported during the same time. An appendix contains the papers read at the last annual convention of the Association of Fire Inspectors of North America.

—*Compressed Air Production:* Rules, Tables and Illustrations Relating to the Theory and Practice of Air Compression and Compressed Air Machinery. The Best Practice in Europe and America compared. By WILLIAM L. SAUNDERS, M. Am. Soc. C. E. New York, 1891. Engineering News Publishing Co., Paper, 6 × 9 ins., pp. 32, 18 cuts and several tables. 50 cents.

This is a reprint of a lecture recently delivered by Mr. SAUNDERS before the students of Sibley College, Cornell University. The author's familiarity with both the theory and practice of his subject enables him to speak with authority, and he has condensed a large amount of interesting and valuable matter in a small space. Literature on this subject is very scanty, and like that on other technical subjects most of it is out of date. There is a somewhat prevalent idea that American practice is behind European in the matter of air-compressing machinery, because the cooling by water injection during compression has been generally discarded by American builders of air compressors, the gain in economy being more than offset by other considerations. Mr. SAUNDERS shows, moreover, that in some cases at least the gain in economy by water injection has been counterbalanced by increased friction. The latest type of Ingersoll-Sergeant Compressor is operated with a friction loss of but 6% and a loss due to heating the air of about half the theoretical or 10.5% in compressing to five atmospheres, making its total efficiency 83.5%. A modern European compressor using water injection has reduced the loss by heating to 1.6%, but the loss by friction of the machine is 14.5%, so that the total efficiency is only 84%, or practically no more than the American. The advantages of simplicity, durability and cheapness in first cost are all on the side of the American machine.

The author has in preparation two other papers in similar form, on the Transmission and on the Uses of Compressed Air; and the three will form a valuable monograph on a subject with which engineers are none too familiar.

—*Municipal Bonds. A Treatise on Investment Securities.* By EBEN HOWARD GAY, Boston, 1891. Damrell & Uphham, publishers. Pamph., 5½ x 7½ ins.; pp. 43; 50 cts.

This pamphlet seems designed to show the superiority of municipal bonds over other forms of investment securities. All the more common classes of bonds are discussed, and court decisions regarding some of them are given. The writer cites as proof of the greater security of municipal bonds the fact that the bonded indebtedness of many municipalities is limited to 5% of their assessed valuation, while the latter is generally not more than one-half the actual valuation. The work seems intended more especially for amateur investors, though, in view of past failures of bankers and brokers, and the securities some of them were carrying, it would seem that this class could learn much from the book. At the close of the pamphlet notable recent advances in the price of municipal bonds in nine cities are given. As an example of these, it is stated that Birmingham, Ala., 6% 30-year bonds were worth 109¼ in 1885, and 123½ in 1890.

—*The American Engineer's Trip over the Cincinnati Southern R. R. to Lookout Mountain.*—This is a very cleverly conceived and executed description of the line of this road, dedicated to the members of the Am. Soc C. E. by the engineering department of the road mentioned. The distances, geology, altitude, general characteristics, and many items of engineering interest are given for each station or point of especial note along the line. It is just the kind of a guide to be appreciated by engineers traveling through what was, to many of them, a new country.

The Engineering Review. Edited by H. C. E. ANDRÉE and EDWARD WALKER, London, England. Monthly, 13s. 6d. per annum.

A new engineering journal in England must require a very sanguine temperament on the part of its projectors and financial backers, when the field is already so well covered by those wealthy and long-established journals, *The Engineer* and *Engineering*. Nevertheless, the attempt is being made, and Vol. I. No. 1 of the above publication is creditable for a first attempt, although a good share of the matter is extracted from other technical journals. Proper credit is given, however, and American exchanges have evidently been looked over quite carefully.

—*Practical Switchwork.* A Hand-Book for Track Foreman. By D. H. LOVELL, Pennsylvania Railroad. Philadelphia: Allen Lane & Scott. 12 mo. pp. 174, 25 cuts, 39 tables. $1.

This is a very good, practical little book in every way, so far as we have discovered. The directions are practical and to the point, and the matter more judicious theoretically than is to be found in most of the engineers' text-books on the same subject, which are apt to split hairs far too much. There is nothing startlingly new in it, to require long review or discussion, which is one reason why we are able to commend it.

—*Handy Rules for Whist.*—Endicott & Macomber, Boston, managers for the Employers' Liability Insurance Co., of London. A little card with the rules of the game in rhyme.

SOCIETY PROCEEDINGS.

New York Railroad Club.—At the meeting on May 21, a paper on "Improvements in Switches, Switchstands and Frogs" was read by Mr. W. F. Ellis, late roadmaster of the Providence & Worcester R. R. The subject of "Drafting Locomotives" was postponed to the meeting in June.

Engineers' Society of Western Pennsylvania.—At the meeting on April 21 Mr. Jno. A. Brashear exhibited specimens of American steel castings. A paper on "Co-operation in Machine Design" was read by Phineas Barnes. The paper advocated more careful study by designers of machinery of the conditions under which their machines had to work.

Liverpool Engineering Society.—Annual meeting of May 6. The following officers were elected for the ensuing session: President, John T. Wood; vice-presidents, H. P. Boulnois, M. Inst. C. E.; R. E. Johnston, M. Inst. C. E.; council, Messrs. Blair, Cottrell, Farren, Miller Mills, Morgan, Potts and Tang; hon. secretary, J. H. T. Turner; hon. treasurer, O. S. Pilkington; hon. librarian, J. A. Brodie.

American Institute of Mining Engineers.—The LIXth meeting will be held at Cleveland, O., beginning Tuesday, June 2. The officers of the local committee are Messrs. Fayette Brown, J. K. Bole, and E. W. Oglebay, secretary. The hotel headquarters will be "The Stillman," with rates to members of $3 per day. Write to hotel to secure rooms. The provisional programme is as follows: Session on Tuesday evening, two on Wednesday, and probably three on Thursday. Visits to local works on Wednesday and probably on Thursday. On Friday morning, visit to ore docks, shipyards, etc., and in the afternoon a trip on the lake. On Thursday evening there will be a subscription dinner for gentlemen and ladies.

American Boiler Manufacturers' Association.—The fourth annual convention was held in St. Louis May 12, 13 and 14. The most important action taken was the passage of resolutions in favor of the enactment of a national boiler inspection law, providing for the compulsory inspection of all steam boilers by Government inspectors, and requiring persons having charge of any boiler plant of 6 HP. or more to pass an examination to determine their competency. The bill was so drafted, however, as not to interfere with the business of boiler insurance and inspection companies.

There was a warm discussion over the comparative merits of machine and hand riveting. It was finally voted to have several boiler shells, riveted by different methods tested to destruction during the next convention, to determine the relative strength of different methods. Tests of the strength of different types of manhole covers and braces will be made at the same time.

The report of the committee on safety valves recommended spring-loaded pop valves with a capacity to discharge 50% more steam than that required for the nominal horse power of the boiler.

The report on the subject of determining the horse power of boilers was referred back to the committee for further investigation. A paper on Drift Pins by F. E. Leonard, of Toronto, defended that tool, and contended that its use was a necessity, and under proper conditions caused no injury to the strength of the sheet.

The following officers were elected: President, Jas. Lappan, Pittsburg; Vice-Presidents, Philip Rohan, St. Louis; Jas. Kenny, of St. Paul, and Chas. Kroeshell, of Chicago; Secretary, E. D. Meier, St. Louis; Treasurer, Richard Hammond, Buffalo. The next convention will be held at Buffalo, beginning June 14, 1892.

New England Water-Works Association.—The tenth annual convention of the association will be held at Hartford, Conn., June 10, 11 and 12, beginning at 3.30 P. M. The headquarters of the association will be at the Allyn House, and the sessions of the convention will be held at Putnam Phalanx Hall, corner Pearl and Haynes streets. Rooms adjoining and connected with the hall will be used by associate members to exhibit water-works appliances. The exhibit will be under the direction of Mr. S. N. Benedict, 301 Main street, Hartford. The charges at the Allyn House will be $3 and at the United States Hotel $2.50 per day. The following papers will be read and discussed:

"Standard Flanges for Water Pipes," by F. C. Coffin, Boston; "On Experience with Water Hammer," by E. E. Farnham, Sharon, Mass.; "Are Lead Pipe Connections for Iron Service Pipes Desirable?" by H. G. Holden, Nashua, N. H.; "The Risks Taken by a City or Town in Having but one Supply Main," by J. C. Hancock, Springfield, Mass.; "The Use of Oakum and Portland Cement in Joints of Water Pipe Under Pressure as a Temporary Expedient," by Stephen E. Babcock, Little Falls, N. Y.; "Three Years' Experience with a Direct Pumping System," by George F. Chase, Taunton, Mass.; "Description of the New Haven Water Company's Dam at Woodbridge, Conn.," by Lucian A. Taylor, Boston; "Dangers Likely to Arise from Building Aqueducts in Form of Tunnels or with Low Grade Lines," by Desmond FitzGerald, Boston Water-Works; "The Relative Taste and Odor Imparted to Water by some Algæ and Infusoria, and Thoughts Suggested by Studies in this Direction," by F. F. Forbes, Brookline, Mass.

During the convention there will be discussions on various questions other than those named in the papers. On Friday those present at the convention are invited to visit the fine reservoirs connected with the city water-works, under the escort of the Water Commissioners. Further information and programs can be obtained by addressing Mr. R. C. P. Coggeshall, Secretary, New Bedford, Mass.

American Society of Mechanical Engineers.—The professional sessions of the coming meeting at Providence, R. I., will begin at St. John's Hall, Masonic Temple, at 10 A. M., June 16. Convention headquarters will be at the Narragansett Hotel, three minutes' walk from the Union station. The following papers are announced:

Two Rope Haulage Systems, R. A. Van Norris.
The Premium Plan of Paying for Labor, F. A. Halsey.
Test of a Triple-Expansion Engine, J. T. Henthorn.
A Belt Dynamometer, S. P. Watt.
A New Belt Testing Machine, G. I. Alden.
Flexure of Thin Elastic Rings, De Volson Wood.
Applications of Hirn's Analysis to Engine Testing, R. C. Carpenter.
Applications of Hirn's Analysis to Multiple Engines, C. H. Peabody.
Notes Regarding Calorimeters, R. C. Carpenter.
Jet Propulsion, J. B. Webb.
Performance of a Steam Reaction Wheel, J. B. Webb.
Heat Transmission through Cast-Iron Plates Pickled in Acid, Daniel Royse.
Steam Engine Efficiencies, R. H. Thurston.
Effect of the Steam Jacket on Cylinder Condensation, W. W. Bird.
Method of Dividing an Index Plate into 1,000 Equal Parts, W. A. Rogers.
A Machine for Cutting Perfect Screws, W. A. Rogers.
Steel Castings, H. L. Gantt.
Manganese Steel, H. M. Howe.
Comparison of Economy of Compound and Single Cylinder Corliss Engine D. S. Jacobus
Performance of a Pumping Engine against a Head of 2,000 ft. of Water J. E. Denton.
A Blast Furnace Blowing Engine. F. W. Gordon.
Some Experiments with a Screw Bolt, Jas. McBride.
Mechanical Stokers, W. R. Roney.

The following topical questions are proposed for discussion at the meeting:

84. What limits are there to the speeds of a hot-air or caloric engine? What is the least and the greatest number of revolutions per minute about which you know in such engines?
85. How many times per minute can a dash-pot apparatus be lifted, such as is used with Corliss' valve gear.
86. Which is better economy in a foundry cupola; to melt rapidly, producing a relatively cool iron, or to melt more slowly, producing hotter iron?
87. Have you had any experience in out-door work at night, in wind and storm, with portable apparatus for light in large quantities, other than electric light?
88. What is the best design for line shafting, transmitting over 50 HP., permitting them to be stopped and started on any floor without interfering with the motor or other shafting?
89. What is the best method of correcting for the superheating of steam in figuring a boiler test?
90. In arranging chimney stacks for a battery of boilers, is it best to use one for each pair or a larger chimney for the entire battery?
91. Will there be any difference in the size of the chimneys required when the boilers are the ordinary tubular type or of some of the water tube forms?
92. What is the best form of cylinder lubricator for engines carrying 140 lbs. of steam pressure or over?
93. What are the maximum safe speeds for hoisting and traversing in an overhead traveling crane in a machine shop?
94. Is there any advantage in using a circular device for the water inside a boiler, particularly of the 3-furnace Scotch form?
95. Is there any best way to group the tubes over the cylindrical furnaces of a Scotch boiler?
96. Can a water pyrometer be made to work successfully for high temperatures?
97. Will a forced circulation of air under a floor near the ground prevent decay of the woodwork and floor timbers?
98. Why should any one cut a half-inch bolt with 12 threads to the inch? Is there any objection to the United States standard for 13 threads?
99. Have you any facts to show that there is a molecular change in metals when their temperature is raised or lowered?

Among the places of interest to which excursions have been arranged by the local committee are the works of the Gorham Manufacturing Co., Wm. A. Harris' Corliss Engine Co., Brown & Sharpe Co., Armstrong & Sims Engine Co., Corliss Steam Engine Co., Rhode Island Tool Co., American Screw Co. and the Pawtucket pumping stations. Invitations to visit many other manufactories in Providence and Pawtucket have been extended. On Tuesday afternoon there will be an excursion to Roger William's Park and on Thursday afternoon a steamboat excursion down the bay to Rocky Point, Newport, etc.

American Institute of Electrical Engineers.—The annual convention was held in New York City last week at the Institute headquarters. On Tuesday evening the business meeting was held, resulting in the election of officers as reported in our last issue.

The report of the Council showed the following gratifying increase in membership:

	May 19, 1890.	May 19, 1891.	Increase.
Honorary	2	3	1
Members	145	161	16
Associate Members	280	377	97
Total	427	541	

The total expenses of the society for the year were $5,213.77, and $738.68 was received from the sale of transactions, etc., making the net "cost of operation" $4,475.09. Ten meetings have been held during the year besides the general meeting, and 25 papers and reports have been read, printed and distributed.

The professional sessions began on Wednesday morning. The first paper read was on the "Perfection of Stationary Electric Motors," by Prof. Francis B. Crocker, of the Crocker-Wheeler Electric Motor Co. The paper was a brief monograph on the general principles of electric motor design. The author believed the general run of electric motors to be much of worse design than the general run of dynamos, the reason being that fewer men of ability had been working on electric motor designing than on dynamos for electric lighting. Again a frequent cause of failure had been the design of a motor to work with some peculiar form of armature or field; the simpler machines have been the more successful. The concluding portion of the paper described the Crocker-Wheeler motor. Discussion on this paper occupied the remainder of the morning session.

At the afternoon session three papers were read. Prof. Edward L. Nichols described "A Photographic Study of the Electric Arc." It is a well-known fact that an alternating current arc lamp hums and sings while burning, no matter what the nature of the lamp mechanism. By photography it was proved that the lamp is actually extinguished and relit at every alternation of the current. Photographs of an alternating current arc light were taken upon a rapidly moving sheet of sensitive paper, and it was found on developing the photograph that a regular succession of light and dark spots were obtained.

Mr. Carl Hering then showed and explained his new wiring chart, from which the proper size of wire may be found by examination, when the number of lamps, their distance and the loss in volts is determined. An interesting paper on applications of the electric welding process, with some hints as to its limitations, was presented by Dr. Frederick A. C. Perrine, of Trenton, N. J. We shall publish a full abstract in a following issue.

In the evening the members assembled in Prof. Dwight's lecture-room in Columbia College, where Mr. Nikola Tesla gave a lecture on "Alternating Current Experiments of High Frequency," performing at the same time many experiments which astonished and delighted his audience. The current used had 18,000 to 20,000 alternations per second, and by a large induction coil the potential of this current was raised to 250,000 volts. The experiments were not only of great interest from a scientific point of view, but they are hoped to have a direct bearing on the problem of producing light by electricity with a much smaller heat loss than at present.

THURSDAY, MAY 21.

In the morning a visit was paid to the Crocker-Wheeler electric motor factory. The professional sessions opened with a paper, by Prof. Geo. S. Moler, of Cornell University, on a new device for measuring alternating current potential, and he was followed by another gentleman from the same institution, who described the fluctuations in electromotive force in the open coil armature of a constant current machine.

Mr. Frank J. Sprague then read a lengthy paper on "Considerations which Should Govern the Selection of a Rapid Transit System for New York City." He advocated, of course, electrical propulsion, and thought an underground system or combined underground and surface system had most advantages.

The afternoon session opened with a paper on "Electric Meters," by Mr. G. W. Walker. The author described the Edison, Westinghouse, Thomson and Aron meters, and also a meter of his own invention, which he naturally believed to be superior, in some points at least, to any of the others.

Two papers on aluminum closed the afternoon session. Neither of them found much favor with the members of the Institute. Dr. Wm. H. Wahl, Secretary of the Franklin Institute, discussed the production of aluminum and thought that the chemical methods of production had been too much neglected, and if properly developed they might yet be able to compete successfully with the electrical methods. Of course this is a piece of rank heresy in the eyes of electrical engineers. Mr. Oberlin Smith then read a paper advocating the name "Alium" for the metal aluminum. His chief arguments for the change are that alium is shorter and easier to pronounce than the established forms. That enough is gained to warrant this radical change from the now generally used word aluminum seems pretty difficult to prove.

The convention closed on Thursday evening with a reception to the members at the Electric Club. An interesting feature of this was a loan exhibition of early electrical literature and electrical appliances.

The Annual Convention of the American Society of Civil Engineers.

The convention was held this year at Lookout Mountain, Tenn., and a special train for Chattanooga left the Grand Central Station, New York, at 10 A. M., May 19. The train was made up of a baggage and smoking car, two sleeping cars and a dining car. It was run as the second section of the Chicago limited express, and made some very good time west of Albany. The ride was extremely pleasant, the track being excellent, the cars comfortable and the weather favorable, and the time was spent very sociably. Luncheon and dinner were served in the dining car, which was afterwards cut off a

Buffalo, N. Y. This car was one built by the Barney & Smith Manufacturing Co., of Dayton, O., finished in oak and brass, with upholstering of dark green leather. Separate chairs were fitted, instead of fixed folding seats, and the tables on one side had seats for four persons, while those on the other side had seats for two. The train left Buffalo about 5 P. M., and the party retired early. The sleeping cars were more efficiently ventilated than many cars of this kind, but were nevertheless unpleasantly hot during the night, and by morning the atmosphere was decidedly offensive. A car-ventilating system which will draw out the hot air, supply fresh air, exclude dust, and be at the same time practicable and economical, is much to be desired. Some fast running was done during the night, over the Lake Shore & Michigan Southern and Cleveland, Cincinnati, St. Louis & Chicago roads, and the train arrived at the Central Station at Cincinnati, O., half an hour ahead of its time, giving ample time for breakfast. Here three cars were added to the train, including an observation car, and the train left about 8:30 A. M. (Central time) with a large party on board. About 42 started from New York, but a number were picked up at different places, the largest number being at Cincinnati. From Cincinnati to Chattanooga the route was over the Cincinnati Southern Ry., which is owned by the city of Cincinnati and leased and operated by the Cincinnati, New Orleans & Texas Pacific Ry. On the train a very interesting pamphlet was issued which had been prepared by Mr. GEO. B. NICHOLSON, Chief Engineer, and gave the distances, altitudes and particulars of various points of interest along the line, especially of bridges, tunnels, grades and other features of engineering interest. At High Bridge, over the Kentucky River, the train stopped, and a number of the party walked across the structure, from which there is a beautiful view of the river scenery. The bridge is a deck structure, with 3 spans of 375 ft. and 275 ft. from water to track level. The piers are of iron on masonry foundations. A number of high iron trestles exist along this line, having generally only an outer wooden guard rail of rather small dimensions and at some distance from the track rail. There was heavy rain during the morning, but during the afternoon the weather was fine and added to the enjoyment of the mountain and forest scenery passed through in crossing Tennessee.

Dinner was taken at the station at Somerset, Ky., and was very acceptable, the train being over an hour late at that place. On the mountain division, between Cedar Grove, Ky., and Oakdale, Tenn., there is some very heavy work, including a number of tunnels. The maximum grade is 60 ft. to the mile. Near Emory Gap the road crosses the Emory River by a bridge which is neither a deck nor a through structure, the track being carried about 8 ft. below the top chord. Chattanooga was not reached until nearly 10 P. M., and there the party changed into the light cars of the Chattanooga & Lookout Mountain R. R., it having been found impracticable to haul the heavy sleepers up this line. The ride was a most picturesque one in the moonlight, with the electric lights of Chattanooga occasionally showing far below. The speed is fairly high for such a line, but while the best view can be obtained from the car platform, one must be prepared to submit to a perfect storm of sparks and cinders from the engine. A late supper and a prompt departure to bed ended a most enjoyable and sociable trip, and one which had been very well managed throughout.

May 21 was a beautiful summer day, but there were many late risers, and the meeting was not called to order until 10 A.M., instead of 9 A.M., as had been announced, but this was excusable under the circumstances. Under the provision of the new constitution the president takes the chair at all meetings at which he is present, and Mr OCTAVE CHANUTE, therefore, occupied the chair. Before proceeding with the reading of papers a committee was appointed to report to the business meeting on the best method of appointing the nominating committee for new officers. This committee consisted of Mr. O. CHANUTE, Mr. F. COLLINGWOOD, Mr. W. P. SHINN Mr. C. B. BRUSH and Mr. GEORGE BOUSCAREN. Some announcements were made by the secretary, and the meeting then turned its attention to business.

The first paper was an interesting one upon "American Irrigation Engineering," which was read by the author, Mr. HERBERT M. WILSON. The paper is a valuable one, and is especially opportune at this time when so much attention is being given to large irrigation enterprises. Attention was called to the fact that the early works of the kind in this country were built hastily to bring in a money return at the earliest possible time, and as the work was not entrusted to experienced engineers, the results were not what were expected, while the financial returns were far below the expectations of the projectors, owing to the heavy charges for maintenance and repairs. Particular attention was given to some of the large projects and completed works of California and Colorado, with details of the dams, canals, flumes, etc. The paper was a valuable contribution to the literature on the subject, and we shall present an abstract of it in a later issue.

In answer to a question as to the difference of effect of clear and muddy water, Mr. WILSON stated that the latter is generally preferred, provided the muddy matter can be held in suspension until the water is flowed over the land. On plowed land a ditch may be made between every 10 or 12 furrows and water from the irrigation ditch be let into each of these in succession by means of a temporary dam. In other cases the water flows over the land, and for rice cultivation the land is flooded deeply. Subirrigation is also carried out for fruit orchards, etc., by carrying a line of earth or iron pipe to the roots of each tree. By this system the greatest duty is obtained from the water. In answer to a question by Mr. J. B. FRANCIS as to the method of making the earth dams tight, Mr. WILSON stated that the general Western practice was to use no masonry or puddle core, although in some cases puddle is laid in a trench and carried up a few feet into the bank. The dams are generally of clayey soil, with an admixture of gravel and small stones. They are thrown up by graders and scrapers and are rammed in layers, not rolled. As a rule the earth is wetted, but the Merced dam was built dry. The average life of timber in dams or cribs he estimated at 10 to 15 years. In an iron aqueduct, in which the plate girders formed the sides of the conduit, the connection with the timber flume gave considerable trouble, owing to the contraction and expansion of the iron. The latter was carried well into the iron conduit and a lead joint made. Another aqueduct has a timber flume carried by the iron work. An iron aqueduct on the Agra canal in India is connected with the masonry conduit by sheet lead. In some cases wooden flumes were carried on earth banks, the latter being allowed to settle, and then trued up before the flume is laid. Leakage of the flumes causes trouble, however. A member stated that on the Mississippi river improvements the banks have slopes of 1 to 3 or 1 to 4. There is no systematic construction, and no puddle is used. In regard to expansion joints Mr. J. B. FRANCIS described a system used by him with boiler iron pipes 6 to 8 ft. diameter. The pipes were fitted telescopically and connected by a ring of curved section, with one leg riveted to each pipe and the legs riveted at the apex, the principle being similar to that of the bowling ring for boiler flues. Mr. WILSON in closing the discussion referred to the admirable work now being done on some of the large enterprises, but stated that engineers had many difficulties to encounter, especially from the demands of the projectors for rapid design and construction, insufficient time being allowed for a thorough hydrographic investigation. More loss and damage are likely to result from the failure of irrigation works, than from bridge failures or badly located railways.

The first paper of the afternoon was by Mr. JOHN E. GREINER on "The Origin and Evolution of the American Railway Viaduct," which was read by the Secretary. Of this paper we shall publish an abstract later on. In the discussion, Mr. GEORGE S. MORISON referred to the design of the Morent Gulch viaduct on the Northern Pacific R. R. The spans are 140 ft. c. to c. of towers, divided into 5 panels, with the width of the top of the tower the same as the panel width, thus making each panel one-sixth of the span. The piers are of iron with 4 columns upon stone foundations. The feet of the two columns on one side, lengthwise of the bridge, are rigidly attached, while the others are provided with cast-iron rockers in order to allow for contraction and expansion. Mr. MOORE thought it would be very difficult to draw a definite distinction between a trestle and a viaduct, and that it would also be impossible to credit the origin of this type of construction to any one person. The paper was also briefly discussed by Mr. GEORGE BOUSCAREN and Mr. THACHER.

The next paper was one by Mr. E. B. DORSEY on "Free Railway Construction vs. Government Railways," in which particular stress was laid upon the advantages of the former in securing low freight rates and good service, as compared with the latter, which, by making it difficult to obtain competitive lines, enables the managers to charge very high rates. The paper was an important one, especially in connection with Mr. DORSEY'S other papers drawing comparisons between American and foreign railways, but it was too sweeping in recommending the free and unrestricted construction, the evils of which have been practically proved in several parts of the United States. Mr. MOORE thought that the paper might well be circulated among the Western people who are clamoring for lower freight rates, as it would show them how low these rates already are in comparison with those of other countries. The showing of the paper, however, was not so good for the owners of the roads, and he thought there might well be some limit to speculative or "blackmailing" construction of lines which were of doubtful use to the owners or the community. He thought a partial adoption of the English system advisable, as in the State of Massachusetts, where a charter is only granted upon the projectors proving to the Railway Commissioners that the road is a public necessity, and the charter must then go before the legislature. Mr. MOORE evidently took the right view on this question, that railway construction should be free, but not unrestricted. A paper by Mr. T. C. CLARKE on "The Advantages of a Longitudinal Bearing System for Railway Tracks," was then read. The paper called attention to the fact that the growing weight and amount of traffic is getting to be too much for the present tracks, causing a large expenditure for maintenance, repairs and renewals, especially at the joints, while rails, ties and fastenings are all failing together. He believed the joint to be an irremediable defect of the cross-tie system, and that the only radical cure of this defect and the other defects of this system, is the use of longitudinal continuous bearings, breaking joint with the rails. With such a system lighter rails might be used. Such a system must have the following features: (1) It must be stiff enough to distribute the pressure so as to limit it to two tons per sq. ft.; (2) the fastenings must be secure, allowing for contraction and expansion, but preventing creeping, and also allowing the rails to be renewed without disturbing the longitudinal; (3) light metallic gage-ties for rails and longitudinals; (4) the shape to be such that they can be easily tamped with gravel or broken stone, which will remain in position, and also allow of drainage; and (5) it must be easily applicable at curves turn-outs and switches. The rail may be of a harder, and the longitudinal of a softer and tougher quality of steel. Basic steel might do for the latter. Reference was made to the Hohenegger system in use in Austria and estimates of the cost were per mile of single track given, aggregating $6,232 for 60-lb. rails and cross-ties with ordinary ties, spikes and joints; $8,739 for 80-lb. rails with long splice bars, interlocking bolts and treated ties; $14,025 for 85 lb. rails on steel ties; and $11,154 for 64-lb. rails on steel longitudinals of the Hohenegger type. A written discussion from Mr. J. F. CROWELL was read approving of Mr. CLARKE'S ideas as to the necessity of improved track and the advantages of the longitudinal system; but the track must be of the best character throughout, including ballast and substructure. Mr. WM. P. SHINN stated that in his opinion track should be perfectly rigid, and not elastic, as this elasticity of the present tracks results in placing a grade of 1 to 2½ in front of the driving wheels and car wheels, every tie sinking from ⅛ in. to ¼ in. under the load. This, of course, is very bad for a service of heavy, fast trains. Such a rigid track would cost perhaps two or three times as much as the present type of construction, but a more complete and permanent track is needed. He thought Mr. CLARKE had presented the right idea, but had not gone far enough in advocating a radical change from the present system. Mr. PROUT thought the metal system described in the paper would not be successful under heavy traffic, and that there would be trouble from creeping. Mr. J. B. FRANCIS and Mr. E. P. NORTH referred to the early use of stone blocks, and their abandonment on account of too great rigidity. Mr. TRATMAN referred to STEPHENSON'S experiment of fastening the rails to solid bed rock, and thought that its failure might have been due to ineffective fastenings allowing a movement of the rails, which were thus battered between the wheels and the rock. Mr. CHANUTE referred to the early Barlow or saddle-back rail and the deep rail placed between two longitudinal timbers. Mr. BRENDLINGER thought such a metal longitudinal system impracticable on account of the great expense, which railways cannot afford. The roads must earn a dividend possible, and cannot put all their money into the track.

A brief paper on "Longitudinals vs. Cross-Ties for Railway Tracks" was then read by Mr. E. E. R. TRATMAN, showing that timber longitudinals are quite extensively used on European railways for carrying the rails across bridges. The tracks of the Great Western Ry., the Forth Bridge and the Severn Bridge were particularly instanced. In English practice there are two general systems of bridge tracks, one consisting of cross-ties and ballast, being practically a continuation of the ordinary roadbed, and the other consisting of longitudinal timbers, usually without ballast. The latter does not give a continuous bearing to rails of the double-head type, as the chairs carry the rail above the timber, but this system is largely used in France and in India and the British colonies, with flange rails laid on the timbers. The longitudinals enable lighter rails to be used, but make drainage more difficult and the work at switches and crossings is more complicated. He thought, however, that good drainage could be secured by laying the longitudinals on a bed of large broken stone and packing them with stone of the ordinary size for ballast. In regard to metal longitudinals, reference was made to the experience on German and Austrian railways, which has resulted in the general use of metal cross-ties instead. This question also comes into consideration with street railway tracks and with some types of compound rails, such as the Bargion rail, now being tried in California. He agreed with Mr. SHINN and other speakers as to the desirability of a radical improvement in track and as to the advantages of a longitudinal bearing, but thought the general adoption of such a system improbable under present conditions, owing to the great expense not only of the track, but of preparing the substructure to carry it. It may, however, be adopted for the railways of the future. In regard to the present system of track, he thought tie-plates to be a very valuable means of effecting improvement, and that a joint that will be really efficient and economical under heavy traffic on a track laid with cross-ties can be, but has not yet been, designed.

A paper on "Mountain Railway Construction," by Mr. WM. B. PARSONS, was read by the Secretary. This paper gave details of the work on some lumber lines in Pennsylvania with grades of 3.316%, operated by Shay-geared locomotives and an ordinary mogul engine. We shall publish

an abstract of this paper. There being no discussion on this paper, the discussion was resumed of a paper by Mr. J. A. HALL on "Right of Way for Railways," which paper was read at a recent ordinary meeting of the society. Mr. SHINN referred to the troubles constantly arising from railways not having proper right-of-way maps and records. The ordinary method of filing original plans by rolling them up and storing them away in a drawer or cupboard is not satisfactory, and on roads with which he has been connected he has had books made of sheets about 30 × 40 ins., using a separate book for each county. The first page is a general plan of the route and property lines through the county, then a right-of-way map for each township, and then the separate property maps. A book of descriptions from the deed or condemnatory papers, etc., is made in connection with the book of plans, and both are indexed and properly titled. The right-of-way agent should not be allowed to make any promise for the construction of any work in securing land without the approval of the engineer and attorney of the company. It is also very important to permanently mark the exact location of the center line, so that the limits of the right of way can be easily located when required. Good reference points should be given, and good substantial monuments should be placed in the roadbed to mark the permanent center line. Mr. GEO. NICHOLSON gave some interesting details of cases in which trouble had arisen over right-of-way questions. Mr. READ and Mr. BRUSH also described methods of present practice in securing accurate deeds, the latter requiring the endorsement of the engineer and attorney. The meeting then adjourned.

In the evening an address of welcome was made by Col. FORT, President of the Chattanooga Chamber of Commerce; Prof. J. M. SAFFORD, State Geologist of Tennessee, made some interesting remarks upon the geology of the region, and Hon. X. WHEELER gave some particulars of the history of Chattanooga and its vicinity. Col. W. R. KING, U. S. Engineer Corps, then delivered an address showing what engineering had done for the development of this neighborhood.

On May 22 a large party was made up for an excursion by boat down the Tennessee River. A brief look at the steel plant of the Roane Iron Works was taken before going on board the stern-wheel, high-pressure steamer "J. C. Warner." The trip was a very pleasant one, the weather fine and the scenery magnificent. The party landed at Shellmound, and returned by special train over the Nashville, Chattanooga & St. Louis R. R. This road has a good track, well ballasted with broken stone, and is laying 70-lb. rails on some parts of its line. The block system is also being introduced, as the traffic is very heavy, but it is operated on the permissive and not on the absolute block system. From Chattanooga some of the party returned to Lookout Mountain by the broad-gage line of the Chattanooga & Lookout Mountain R. R., which is operated on the adhesion system by powerful tank engines built by the Brooks Locomotive Works, while others returned by the electric line to the foot of the mountain, the cable road up the steep side, and then the narrow-gage line to the hotel. In the evening the President, Mr. OCTAVE CHANUTE, read his address, which was illustrated by excellent stereopticon views from photographs of several of the works referred to in the address. At the conclusion, a number of photographs of the interior of Luray Caverns Jewell Cave and the Weyer Cave were exhibited by the stereopticon by Mr. P. C. HOVEY. The following is an abstract of the President's address:

Mr. CHANUTE commenced by stating that the field of engineering has now grown so large and in so many different directions that it would be impracticable to give a complete review, and he would therefore select some of the leading engineering works of the past year, showing the advance which they indicate upon previous practice.

Tunnels.—The principal works of the past year have been in connection with tunnels. The new Croton Aqueduct was completed, which is practically a rock tunnel 30 miles long, under the charge of Mr. A. FTELEY, Vice-President of the Society. It was opened July 15, after having taken 5 years in boring. Its full daily capacity is 318,000,000 galls., and its cost to June 30, 1890, was $23,561,973. The St. Clair tunnel under the St. Clair River for the Grand Trunk Ry. was successfully driven under the supervision of Mr. JOSEPH HOBSON, M. Am. Soc. C. E. A similar work at Detroit was abandoned 17 years ago after considerable money had been spent in trial headings, and the Hudson River and other submarine tunnels have been delayed by the difficulties thought by capitalists to be involved in such work, but after the success of the St. Clair tunnel capital is likely to be furnished for other projects of the same kind. The Hudson tunnel work now in progress the new projected Detroit tunnel, the tunnels of the City & South London Ry., London, England; the Jennings & Stunnard method of tunneling employed for a tunnel in London, England, 1,563 ft. long and 26 ft. diameter, in which steel "needles" are employed; the drainage tunnel and Nochistongo cut at the City of Mexico, and the English Channel tunnel between England and France for which the Beaumont machine for cutting the chalk was used until work was stopped nine years ago, were also referred to. This latter tunnel will be, if completed, 23 miles long, of which about a mile has been bored at each end. The Poetsch freezing process as applied to tunneling was also described. [All of these works have been described in detail in ENGINEERING NEWS].

Marine.—The commercial fleet on the Great Lakes consists of 1,217 sailing ships and 1,435 steamships, as compared with 1,408 and 868, respectively, ten years ago, while the maximum size has increased from about 1,200 to 1,900 tons for the former and from 1,500 to 3,000 tons for the latter. This increase in size has been caused by the competition of the railways and their reduction of rates, economy in water transportation being secured by increasing the size of the vessel. The general government has in several cases increased navigable depths from 13 to 16 ft., but the new steamers which carry 2,500 tons with 15½ ft. draft, could carry 3,000 tons with 18 ft. draft. Improvements are therefore being made at the Sault Ste Marie and other points which will give a navigable depth of 20 ft. between Buffalo and Duluth. The ship railway and canal projects, in connection with the lake navigation, were also referred to, including the Lake Erie and Ohio River Ship Canal. The Chicago Drainage Canal will provide incidentally for navigation between the lakes and the Mississippi at a cost of $20,000,000 to $28,000,000.

Ship Railways.—Chignecto line and the Tehuantepec and the Hurontario projects were referred to, as well as the method patented by Mr. SMITH, of Aberdeen, Scotland.

Railways.—The extension of operating and safety appliances has continued, and the application of signals steam heating and gas lighting for passenger cars, and of power brakes and automatic couplers for freight cars has progressed rapidly. With regard to the latter, a recent issue of ENGINEERING NEWS states that companies controlling nearly 87,000 miles of railway (over half the total mileage of the country), and 697,000 freight cars have adopted the Westinghouse automatic brake and are applying it either to all new cars or to certain classes of new cars, over 150,000 cars or 13% being now equipped. Also that on Jan. 1, 1891, the total number of cars equipped with M. C. B couplers was over 102,000, or nearly 9% of the freight rolling stock of the United States. President SHINN stated last year that there were 101,576 freight cars equipped with Westinghouse brakes, and 56,050 cars with M. C. B. couplers. The Shay geared locomotive was referred to [ENGINEERING NEWS, April 26, 1890, and April —, 1891] as one of the latest novelties in locomotive design. Ten years ago the standard freight car had a capacity of 10 tons and weighed 9 tons. Now the standard car has a capacity of 20 tons and a weight of 12 tons, while cars of 25 to 30 tons capacity are not uncommon, the latter weighing 15 tons. It may be, however, that we are in danger of going too far in this direction, and losing in the increased wear of rails what we gain in haulage expenses. Weights used to be limited to 12,000 lbs. on driving-wheels and 8,000 lbs. on freight-car wheels, giving pressures of 50,000 to 60,000 lbs. per sq. in., but by imposing weights of 16,000 to 18,000 lbs. on driving-wheels and 11,250 lbs. of wheels of 30-ton freight cars, we may be rapidly crushing or grinding the rails. Terminal improvements have not kept pace with other economies. Switching yards might be better arranged, cranes more generally used and some mechanical methods introduced for handling and conveying freight from the receiving doors to the cars, in order to reduce the large gangs of men now engaged in trucking. The Pike's Peak Ry., in Colorado, built on the Abt rack-rail system, with a maximum grade of 25%, was referred to. Among other mountain railways were mentioned the Mount Pilatus Ry. (48% grade), the Jungfrau Ry. (98% grade), and the Transandine Ry. (8%). The gliding or hydraulic railway was described, and its principle of supporting the train upon a thin film of water under high pressure was suggested as possibly applicable for journal bearings, cranes and drawbridges. The Siberian Ry., which is being built by the Russian Government, will be 5,000 miles long, and there are 2,156 miles to be built in about 6 years at a cost of $103,000,000. Russia has 20,000 miles of railway for 92,000,000 inhabitants. With such increased activity in railway construction there may be an opportunity for the employment of the rapid and cheap American methods and tools. The average cost of railways in the United States is about $60,000 per mile, while those in Europe are capitalized at about $120,000 per mile, the difference being largely due to the cheaper methods and designs developed by engineers in this country, owing to the original scarcity of capital and labor. Americans are now the great railway builders of the world, executing enterprises with less expenditure of money and labor than other nations, and it is not improbable that firms of American engineers and contractors may find it profitable to employ these methods in other countries.

Highways.—Increased attention is being given to the improvement of roads, as after railways have effected economy in transportation to distant markets, further economy can now be effected by improving the roads over which produce is hauled to the railways. An association to aid this movement has been formed by members of the society.

Metallurgy.—In 1890 our production of iron and steel was for the first time greater than that of any other country, owing to the increased use of these materials for structural purposes and engineering works. The production was 10,307,028 net tons of pig iron, 2,804,829 tons of rolled iron exclusive of rails, 2,091,978 tons of Bessemer steel rails, and 1,829,247 tons of rolled steel exclusive of rails.

Bridges.—Among the bridges built in 1890 were the following: The Red Rock cantilever bridge, with a center span of 660 ft. including 330 ft. suspended span; the terminal elevated railway for the St. Louis Merchants' bridge; the Wheeling & Terminal Ry. bridge over the Ohio at Wheeling, W. Va. (108 ft. to 525-ft. spans, the 518 ft. channel span weighing 4,000,000 lbs., and being the heaviest truss span yet built in America); the Richmond, Fredericksburg & Potomac R. R bridge over the James river at Richmond, Va., consisting of 11 pin-connected deck spans of 176 ft., and 180 ft. of viaduct of 30 and 60-ft. girder spans at each end. The main span of the Ohio Connecting Ry., single track, 523 ft. long, weighing 915 tons, was erected by building the falsework on barges and floating the completed span into place in the manner carried out at the Hawkesbury bridge in Australia. The operation was performed on Aug. 19, 1890. The work was superintended by Mr. C. L. STROBEL, M. Am. Soc. C. E. The Newport & Cincinnati bridge is for highway and street railway traffic, with a floor system designed for a 15-ton steam roller. On the single track bridge over the Mississippi River at Winona, Minn., for the Winona Ry. Co., work of driving foundation poles was commenced Aug. 16, 1890, completed Oct. 23, masonry finished Jan. 6, 1891. The Arkansas River bridge for the Kansas & Arkansas R. R. at Fort Smith, Ark., has 10 spans of 200 ft. and a draw span of 370 ft. Of foreign bridges, the Tower bridge at London, the Malleco River bridge in Chile, and the St. Giustina bridge in the Tyrol were mentioned. In regard to the artistic effect and appearance of bridges, there is more liberality of capital now to allow of giving such an appearance, and the effect will follow by simply arranging the outline to follow the lines of maximum strains, as in the cases of the Merchant's bridge at St. Louis and Mr. BOLLER'S Thames River bridge at New London, Conn. European engineers are more careful in this respect. [For descriptions of the above bridges see late volumes of ENGINEERING NEWS].

Buildings.—The construction of high buildings with metal framing is increasing and calls for considerable engineering work. Chicago alone has 8 or 10 office buildings 10 to 14 stories high, and 6 or 8 more are well under way, one of the latter being 113 × 170 ft. square and 274 ft. high from the sidewalk. The walls are merely a shell, in some cases resting on the girders, all the weight being carried by the interior ironwork construction. The walls need be no more than 8 ins. thick. The subsoil of Chicago consists of blue and gray clay, and for very heavy loads foundations of rails bedded in concrete are used, distributing the weight over the clay at 1½ to 2 tons per sq. ft.

Electrical Engineering.—The rapid increase in the use of electricity for light, traction and power in various directions was referred to, particularly in the case of the Bridgeport drawbridge. The first commercially successful electric railway was built in 1885, and now America has 2,931 miles, as compared with 554 miles of street railway operated by steam motors, 527 by cable, and 5,713 by animal power. The 2,931 miles are nearly all operated by the overhead trolley system, with 4,407 motor cars and 6,000 tow cars. The speed averages 7 to 10 miles per hour, with a maximum of 20 miles, and the maximum HP. generated by a single electric car is 75 HP. Whether this system can be applied to ordinary railway work seems doubtful. Of storage battery cars one of the most successful is the Waddell-Entz car at Philadelphia. The Weems railway was also referred to. There are said to be now in use in this country, operated from central stations, 1,740,000 incandescent and 154,000 arc lights, and 900,000 incandescent and 25,492 arc lamps operated from isolated plants. There are 411,511 telephones, with 171,454 subscribers, and the longest telephone in regular use is that between Portland, Me., and Buffalo, N. Y., 750 miles.

The Society's Affairs.—There is sustained interest in the Society, but the supply of papers during the past year has not been as liberal as desirable, too many having been postponed until convention time, and the recent growth and improvements in the technical press has probably interfered with the preparation of papers to some extent. Fuller and more complete descriptions than can be published by the press, however, should be presented to the Society as records of work done. The importance of free discussions was dwelt upon, and members were requested to notify the secretary of the class of subjects in which they are most interested, in order that advance copies of papers may be sent to them for discussion. In connection with the Columbian exposition of 1893, it was suggested that American engineers might take the opportunity of returning the courtesies and attention shown to them in Europe in 1889, and arrangements are being made to provide headquarters for engineers who may visit the exposition. An evolution in the condition of the engineer seems to be taking place in this country, as it has already taken place in England, and there are good grounds for believing that there will result within the next few years a marked improvement in the independence, in the standing and in the emoluments of the American civil engineer.

(To be continued.)

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

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Advertising rates, 20 cents per line *agate measure. Schedule sent on request.* **Changes** *of advertisements must be in hand on Tuesday afternoon;* **New** *advertisements Wednesday afternoon;* **Transient** *advertisements not later than Thursday noon. The last pages go to press early on Friday, and we shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.*

COMING TECHNICAL MEETINGS.

Civil Engineers' Society of St. Paul.—June 1. Secy., C. L. Annan.
American Institute of Mining Engineers.—June 2. Fifty-ninth Meeting, Cleveland, O. Secy., E. W. Raymond, 13 Burling Slip, New York.
Western Society of Engineers.—June 3. Secy., J. W. Weston, 280 La Salle St., Chicago.
Engineers' Club of St. Louis.—June 3. Secy., Arthur Taatcher. Room 801, Odd Fellows' Building.
Engineers' Club of Minneapolis.—June 4. Rooms, Public Library Bldg. Secy., F. W. Cappelen.
Technical Society of the Pacific Coast.—June 5. Secy., O. von Geldern, 819 Market St., San Francisco
Association of Civil Engineers of Dallas.—June 5. Secy., E. K. Smoot, 803 Commerce St.
Engineers' Club of Philadelphia.—June 6. Secy., Howard Murphy, 1122 Girard St.
American Society of Swedish Engineers.—June 6. 250 Union street, Brooklyn, and 347 North Ninth street, Philadelphia.
Engineers' Club of Kansas City.—June 8. Rooms, Baird Building. Secy., H. Goldmark.
Civil Engineers' Club of Cleveland.—June 9. Secy., A. H. Porter, 50 Euclid Ave.
American Railway Master Car Builders' Association.—June 9. Annual Convention, Cape May, N. J.
Denver Society of Civil Engineers.—June 9. Secy., Geo. H. Angell.
Civil Engineers' Association of Kansas.—June 10. Secy., J. C. Herring, Wichita, Kan.
Engineering Association of the South.—June 11. Secy., John H. Lanahreth, Vanderbilt University, Nashville, Tenn.
Northwestern Track and Bridge Association.—June 12. Secy., D. W. Meeker, St. Paul, Minn.
American Railway Master Mechanics' Association.—June 16. Annual Convention, Cape May, N. J.
Engineers' Society of Western Pennsylvania.—June 16. Secy., J. H. Harlow, Pittsburg, Pa.
American Society of Mechanical Engineers.—June 16-20. Annual Convention, Providence, R. I. Secy., F. R. Hutton, 12 West Thirty first street, New York.
Boston Society of Civil Engineers.—June 17. Secy., S. E. Tinkham.
Engineers' Club of Cincinnati.—June 18 Secy., J. F. Wilson.

A COMPLAINT commonly heard from young engineers, and occasionally from old ones also, is that they do not find in engineering literature adequate discussions and hints as to the details of minor structures. In many engineering books full descriptions of very large and important structures are given, which are in a sense superfluous, because such structures warrant and demand even more detailed investigations of prior structures of the same kind than can possibly be given in a general treatise, while the proper construction of the minor structures, which occur in great numbers on every road, is dismissed with a few paragraphs only, and, more often than not, vague and misleading paragraphs. This is in every respect unfortunate, because the safety of trains, or of a canal, or aqueduct, is often as seriously imperiled by a defective culvert as by a defective bridge, while the chances of such defect are much greater for the culverts, both on account of their number, and because they are less carefully and seriously studied.

Some practical hints on the design of these minor structures will be found in an article by Mr. A. J. SWIFT, Chief Engineer of the Northern Departmen of the Delaware & Hudson Canal Co.'s railway, the publication of which we begin this week. The paper was presented as a lecture in the course planned by Prof. P. C. RICKETTS for the students of the Rensselaer Polytechnic Institute, and was printed in the *Polytechnic* for May, a journal which ranks among the best of those published by the technical schools.

To make this paper (as we hope) still more useful to young engineers, we have added some further notes or cautions where they seemed to be called for, or likely to be useful. Opinions will differ as to such details, and within certain limits may properly do so, as also as to what is or is not important enough to deserve mention. We desire to call special attention to Mr. SWIFT'S notes as to protecting the lower ends of small structures against undercutting by wash, a too much neglected matter.

It is due to Mr. SWIFT to say that his paper was only prepared for the benefit of the students before whom it was read; and it is only by our special request that he has consented to its publication in ENGINEERING NEWS. Our added notes, therefore, are not to be taken as criticisms upon the author's ideas or practice, as they refer chiefly to additional details which would possibly have been included by the author himself had he intended the article for publication.

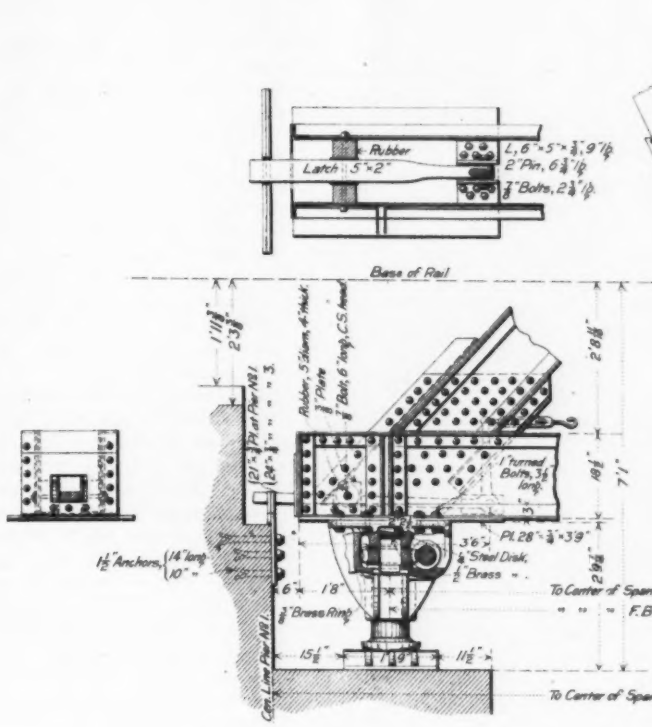
THE paper on free railway construction by Mr. EDWARD BATES DORSEY, elsewhere reprinted, is more valuable from a historical point of view than for its bearing on present relations between the public and the railways. Undoubtedly the absence of legal restrictions upon railway construction has resulted in giving to this country a railway system superior on the whole to that of any other country in the world at a minimum cost. But because a policy has worked great benefits during the period of construction, it does not follow that it will continue to be of advantage when all parts of the country are well supplied with transportation facilities.

Competition has been a great factor in reducing railway rates in the past, because the new competing lines which have been built have for the most part been warranted by the growth of traffic. But the paralleling of existing roads of capacity ample for the traffic is now generally conceded to be against public policy; and while it may result in a temporary cutting of rates, in the end the public must pay for the operating expenses of two roads when one would have served the purpose as well. Apropos of this, the following extract from a report of the Kansas Railroad Commission is of interest, since Kansas is a state where free railway construction has been carried to a great extreme and has given to the people a greater mileage of railways than they can support:

> It is not wise, neither is it conducive to any permanent or substantial interest, either of the public or of railroads, to construct two or more lines parallel and so near each other as to divide a local business insufficient for one. The people who from such a conjecture of affairs expect competition are deluded, and the men who venture their money in such an enterprise are equally "left."

THIS is a fair statement of the opinion which is now generally held by careful students of the railway problem. But there is another reason why free railway construction cannot be relied on to keep down traffic rates. The amount of capital necessary for the construction of a competing railway line is greatly increased when it must be built through a thickly-settled country, in accordance with modern ideas of safety and solidity, and must secure independent terminals at great cost in the principal cities. Further, the railways of the country are fast being concentrated in a few great systems. We showed over a year ago that eleven railway companies now control over half the mileage and at least five-eighths of the traffic of the country. At present probably 80 per cent. of the railway mileage is comprised in systems 500 miles or more in extent. It was comparatively easy to collect capital for the construction of a competing railway in the days when great railway systems were unheard of; but capitalists are not anxious to enter into a fight with a corporation controlling a thousand miles or more of railway lines. In the rate war which always follows the paralleling of a line of road, unless the old and new companies combine to maintain rates, the weaker competitor goes to the wall; and the weaker competitor is generally the new road. It was so in the cases of the West Shore and the Nickel Plate and in the Philadelphia extension of the Baltimore & Ohio, even though the latter enterprise was backed by an old, established company. Free railway construction has doubtless worked great benefits to this country in the past; but as we approach in density of population the countries of Europe, we too shall find it necessary to interpose some check on the schemes of irresponsible promoters and to prevent private property from being taken by eminent domain, unless the construction of the road promises to be on the whole for the public benefit. This, in fact, has already been done in Massachusetts, where the law requires that the Railroad Commission shall approve the location of a proposed railway, and certify that the public exigency requires its building, before construction can be begun. This law has been in force since 1882; and we are not aware that its practical working has been such that a movement has ever been made for its repeal, although a number of railway projects have been disapproved by the Commission.

IN TWO articles recently contributed to the *Fortnightly Review* the Duke of Marlborough has given to the English public the impressions of American mines and railways derived from his recent trip through this country. These articles are most appreciative and on the whole marked by good judgment, but they display in a conspicuous degree that amusing ignorance of American geography which is generally prevalent in English journals. We find the Chicago & Northwestern, the Chicago, Milwaukee & St. Paul, and the Great Northern systems spoken of as being in the *Southwest* instead of the *Northwest*; the Richmond & Danville is mentioned as running from Kansas City, Mo., to Washington, D. C., while in fact its western terminus is at Greenville, Miss., over 450 miles southeast of Kansas City. The Louisville & Nashville R. R. and the Baltimore & Ohio R. R. are spoken of in a manner that implies that they are competitors, whereas they occupy totally different parts of the country; and, again, the Louisville & Nashville R. R. is said to be "eating into" the territory of the Norfolk & Western R. R. in western Virginia, while in fact the relations of the two companies are very friendly and the Cumberland Valley extension of the Louisville & Nashville, which is evidently regarded as an evidence of encroachment, was built by joint arrangement with the Norfolk & Western Co., and is intended to furnish its lines an outlet to the west. In other places we find mention made of the "Connersville coke-field," instead of the Connellsville coke-field; Atalanta, Ga., instead of Atlanta, Ga.; and Cranbury, N. C., and Johnstone City, Tenn., instead of Cranberry, N. C., and Johnson City, Tenn. The duke closes his discussion by outlining an English combination to cope with the existing combinations. It is proposed to take the Norfolk & Western R. R. as "a nucleus," and "suppose that it has control of the Tennessee Valley from Knoxville to Norfolk," and "that it has allied itself to the Kentucky Union, and that it has consolidated with the Central Railway & Banking Co., of Georgia;" to these are to be added the Illinois Central, the Charleston, Cincinnati & Chicago, and the Missouri, Kansas & Texas railways. Considering that the Central R. R. of Georgia already belongs to the Richmond & West Point Terminal combination, and the location of the other



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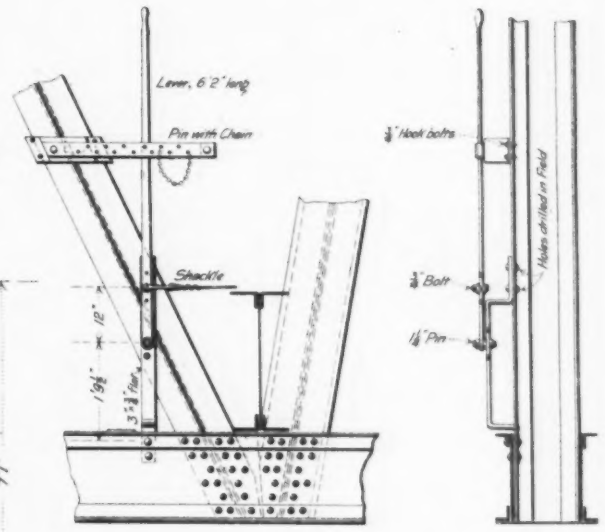

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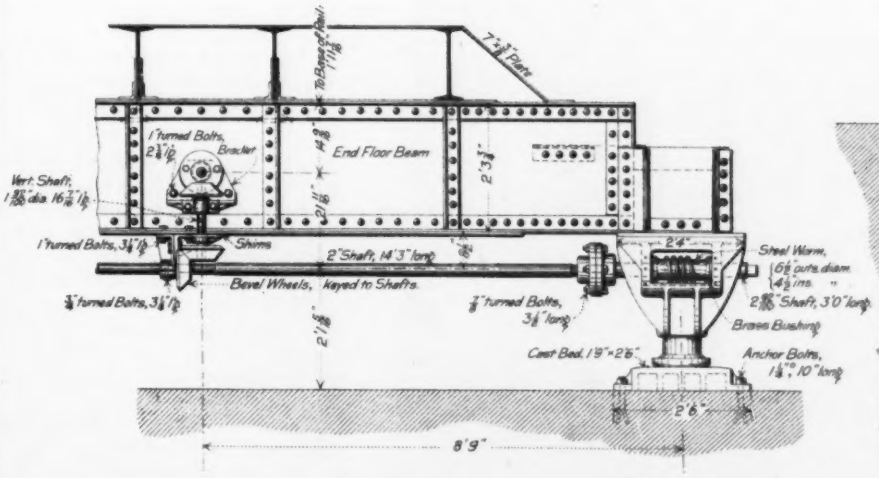

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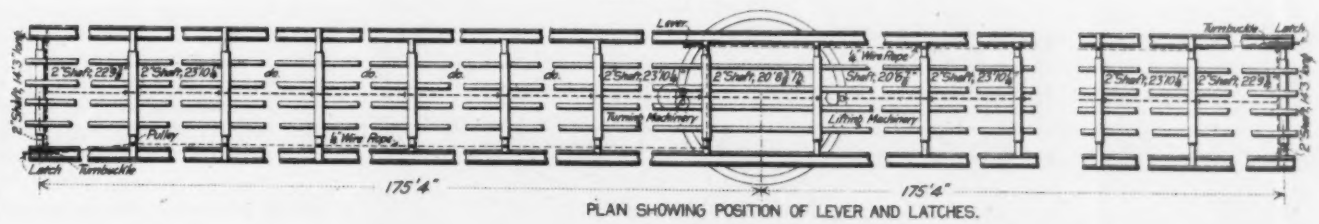

PLAN SHOWING POSITION OF LEVER AND LATCHES.

MACHINERY FOR OPERATING TH

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G. A. MOUNTAIN, CHIEF ENGINEER CANADA ATLANTIC RY.

PHELPS JOHN
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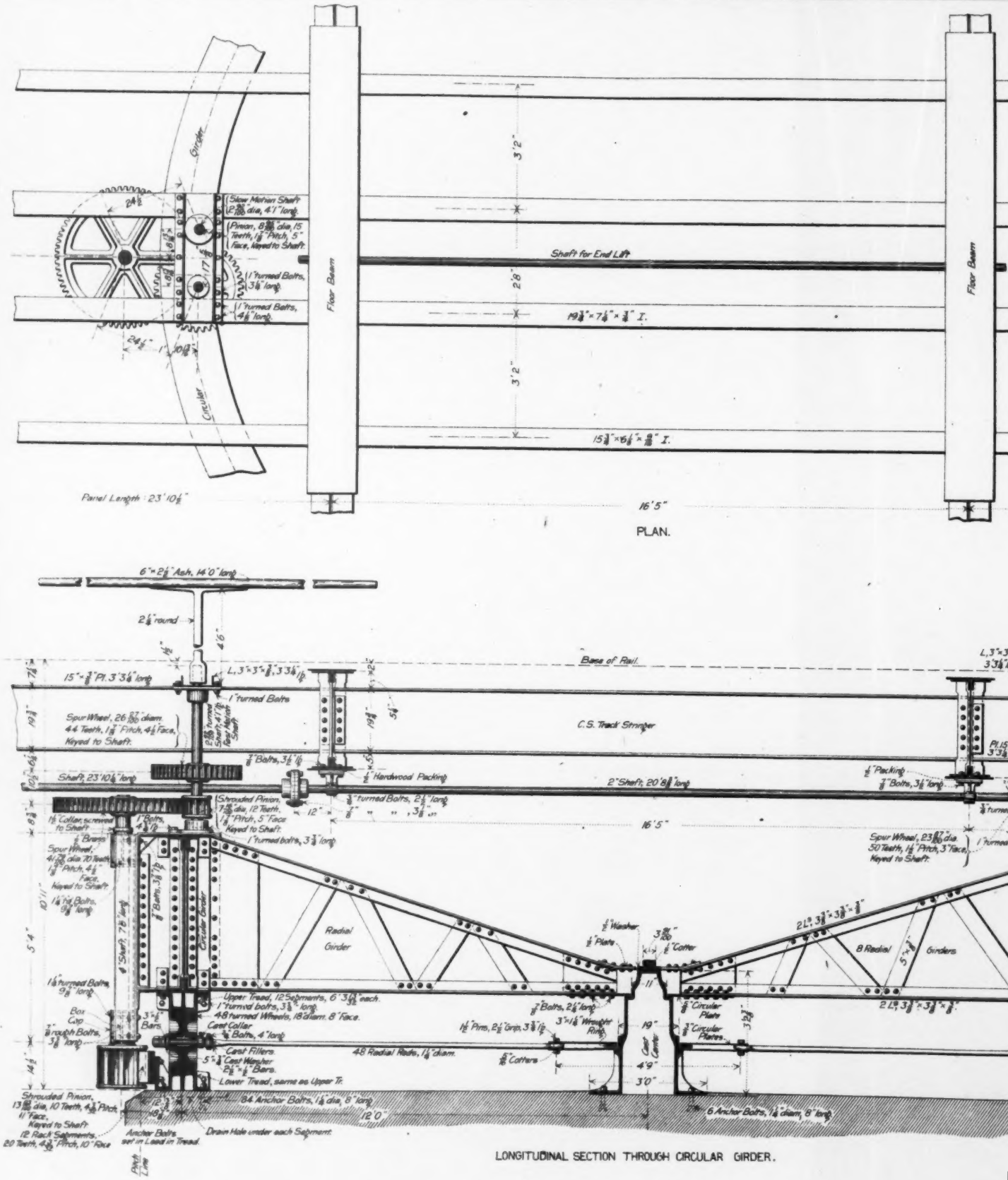


PLAN.

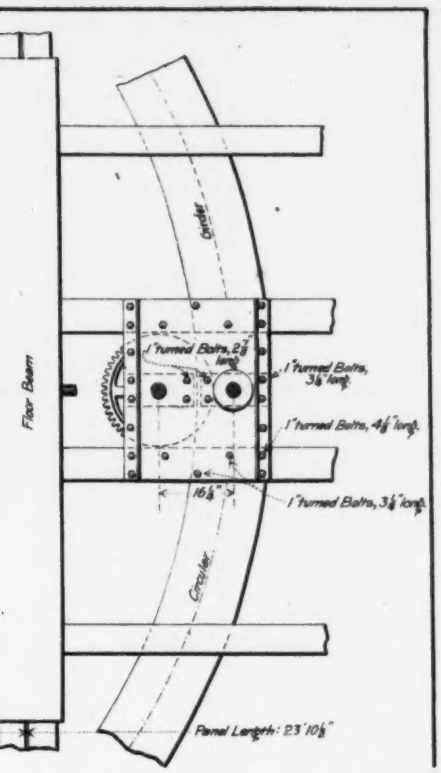
LONGITUDINAL SECTION THROUGH CIRCULAR GIRDER.

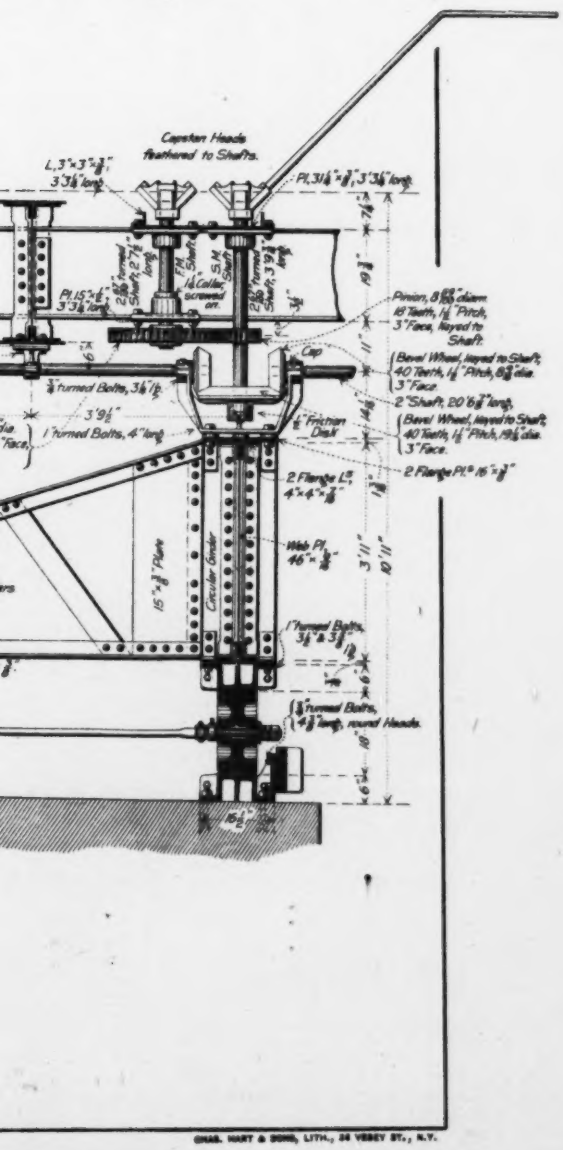
OPERATING THE SWING SPAN OF THE COTEAU BRIDGE,

TLANTIC RY. OVER ST. LAWRENCE RIVER AT COTEAU, QUEBEC.

PHELPS JOHNSON,
GEORGE H. DUGGAN, } ENGINEERS DOM. BRIDGE CO.

DOMINION BRIDGE CO., LTD., CONTRACTORS.





CHAS. HART & SONS, LITH., 24 VESEY ST., N.Y.

lines mentioned, the precautionary statement that he is "not suggesting a hard-and-fast scheme" is well put in.

IN a memoir upon water meters, read last week before the American Society of Civil Engineers, at Lookout Mountain, Mr. JOHN THOMSON justly remarked that there is a demand on the part of corporations for altogether too much accuracy in water-measuring machines. He says that an error of five to seven per cent. would really be unimportant when the essential purpose of a water service is considered; and that the resulting gain from this allowance of error would be a much less costly and yet a more durable meter. We fully agree with Mr. THOMSON. Water is sold by the gallon and not by the drop; and the only reason for measuring it out through a meter is to closely approximate to the actual quantity furnished, and to thus check the wholesale waste prevalent under the older methods of service. A few hundred gallons more or less, in a year, in the amount furnished to a consumer, is of little real importance; but it is important to stop the same man from absolutely wasting thousands of gallons in the same period. Water is a commodity that should be made as nearly free as possible for all legitimate use; and a serviceable meter is the best regulator of this legitimate use. Its utility is fully recognized by all purveyors of water, and the comparatively expensive character of the machine and the cost of keeping it fully up to established standards of accuracy are the only limits to its common adoption. If the small error mentioned by Mr. THOMSON will enable the price to be reduced from 25 to 30 per cent. below present market prices, and at the same time furnish a meter that will cost less in repair, there seems to be no good reason for rejecting his advice. A change of this kind would at once vastly extend the use of meters, and no one can question the gain in waste prevention, as compared with the older and very reckless methods of furnishing water. With only 6 meters, as yet, to every 100 taps in the United States, our readers can judge for themselves of the field still to be covered by this useful regulator of domestic and general water supply.

SOME of the questions for topical discussion at the Providence meeting of the American Society of Mechanical Engineers, which we publish in another column, seem to need a few alterations before discussion. For instance, No. 93 is, "What are the maximum safe speeds for hoisting and traversing in an overhead traveling crane in a machine shop?". The obvious answer to this is that it depends on the crane and the machine shop. This, however, is not in such bad form as No. 99, "Have you any facts to show that there is a molecular change in metals when their temperature is raised or lowered?" It may be humbly suggested that the increase in size when heated and decrease when cooled, commonly called expansion and contraction, seems to show a "molecular change." Perhaps the propounder of the question meant to say "change in molecular structure," but even then the question seems a useless one, for the phenomena of hardening, tempering and annealing are familiar to every mechanical engineer.

The Outlook for Manufactured Fuel Gas.

The paper by Mr. GEO. H. CHRISTIAN, Jr., on the outlook for manufactured fuel gas, which we publish in another column, gives some interesting figures concerning the possibilities of fuel-gas manufacture and distribution. If there ever were any doubt concerning the enormous advantages of gas fuel over coal for domestic purposes and for many industrial purposes, it has been permanently set at rest by the extensive use of natural gas. Not every city and town can have natural gas; but those that are outside the natural-gas region, and, for that matter, those that are inside which are experiencing the gradual decrease of production that betokens the ultimate exhaustion of this valuable gift of nature, have great interest in the question whether a fuel gas can be made and sold cheaply enough to compete with coal. It will be noted that Mr. CHRISTIAN does not give a categorical answer to this question. There are too many complicated circumstances involved to permit this. The cost of coal, the density of the population to be supplied, the wealth per capita, the demand for industrial purposes, the prospects of a secure franchise for a private corporation operating its mains beneath public highways,—these are a few of the many things which must be considered in determining the price at which fuel gas can be furnished to any community.

What the author does give is a statement of the present efficiencies of fuel-gas manufacture and use, from which we may fairly conclude on the one hand that present fuel-gas processes will not bring the total revolution in the use of fuel which some enthusiasts have claimed, and, on the other, that a fuel-gas distributing plant stands a very fair show of commercial success when introduced under favorable conditions.

There is a somewhat prevalent error in the public mind on the fuel-gas question. It is that by some hocus-pocus or other it is possible to get out of a pound of coal a quantity of fuel gas having a much greater heating value than that possessed by the carbon and hydrogen contained in the coal. Probably there are not many engineers who hold such an erroneous belief; but there are perhaps a good many who have been enough infected by the trash on this topic which has been current in newspapers and a certain class of technical journals for a score of years, to believe that the loss in absolute heating power in converting coal to fuel gas is very little indeed. How far this is from the truth, Mr. CHRISTIAN'S paper shows. The loss in good practice varies from 30 per cent. in making carbureted water gas to 36 per cent. in making water gas, and 40 per cent. in making a combined coal and water gas.

Another extremely common error is that the efficiency of combustion of gas is nearly perfect. Every one knows that in burning coal more or less unburned fuel is lost in the ashes, and many are aware of the fact that a portion of the carbon has its heating power only partially utilized, being burned only to carbon monoxide. But a gas flame shows no smoke, and there is no solid residue from it. The popular idea, therefore, is that its combustion is perfect The author shows, however, that in burning a fuel gas, especially one containing a large percentage of heavy hydrocarbon vapor, a considerable part of the combustible elements of the gas may escape unconsumed. He claims, in fact, that under ordinary conditions of domestic service natural gas generates but 33 per cent. of the heat contained in it; and he expects only from 60 per cent. to 70 per cent. efficiency from the most easily burned gases. Taking the higher figure, and allowing 70 per cent. efficiency for the process of making the gas from the coal, it appears that only about 50 per cent. of the heat units in the coal is all that can be generated by burning a fuel gas obtained from it. As almost any good boiler will utilize more than 50 per cent. of the heating power of coal, it is plain that there is a loss instead of a gain in using fuel gas in place of coal under boilers, even when the gas is generated and burned with the highest practicable degree of efficiency.

But in burning coal for domestic purposes, no such high efficiency can be obtained as in burning it in a steam boiler furnace. The author estimates that not more than 33 per cent. of the heat obtained in the coal is generated in burning coal in a fairly good stove. This estimate, as well as his estimate of the efficiency of solid fuel burned under boilers, seems surprisingly low; and it is possible that the author's desire to make out a good case for fuel gas somewhat prejudiced him in estimating the efficiency of coal combustion. He bases this efficiency of 33 per cent. on the supposition that 25 per cent. of the total weight of fuel is ash or is lost in the ash, and that of the fuel consumed, three-fourths is burned only to carbon monoxide. Both these assumptions seem to represent the most wasteful rather than average practice, although positive knowledge on the subject is lacking.

A careful investigation of the actual efficiencies obtained from fuel in domestic heating would be of much value in estimating the possibilities in the use of fuel gas, as well as in demonstrating the chances for improvement in existing coal stoves and furnaces. Things of far less economic importance have been investigated and discussed until they are worn threadbare.

Many millions of dollars' worth of fuel are burned every year in this country for domestic purposes, and if in general practice less than one-third of the heat contained in this fuel is ever converted into heat, it is time the fact were generally known. Of course there is a great loss of heat after it is generated in ordinary household practice by excessive air supply and imperfect means for conveying away the heat from the fire, but that is not now in question, and must exist to some extent with gas fuel also.

It is quite true, however, that in burning solid fuel, in domestic use, great waste is to be expected. It will inevitably be burned with neglect and inefficiency, because the actual amount lost is too small to pay for the extra care necessary to prevent it. Herein lie the opportunities for economy in the use of gas for fuel. The appliances for burning it require little attention to secure good results compared with that necessary for a coal fire, and the heat can be obtained just when and where it is wanted. Thus, although the cost of gas is much greater than that of coal for an equal heating power, the greater waste with the solid fuel may make it really the more expensive.

While Mr. CHRISTIAN'S paper does not give all the facts necessary to determine the rate at which fuel gas can be profitably sold, it gives enough to prove pretty well the truth of his statement that this rate is very much lower than has been generally supposed by gas superintendents. Fuel gas is now sold in Boston at 60 cts. per 1,000 cu. ft.; and if this price yields a fair profit there, a price considerably less should be possible in cities near the gas coal fields. At 50 cts. per 1,000 ft., the author calculates that gas is as cheap for equal heating value as hard coal at $7.50 per net ton; for while the total combustible in 15,000 cu. ft. of gas has but half the heating power of that contained in a ton of coal, the gas burns with about double the efficiency. If these figures are correct, the way is open to very large use of fuel gas for domestic purposes. With gas there is no expense for handling fuel, attending fires, or disposing of ashes. The obvious advantages of gas for cooking, in place of the fuel-devouring range, need only be mentioned.

The author's paper refers chiefly to the domestic use of gas; but its use for industrial purposes, which accompanies its domestic use, will be of great importance. The gas engine should make a great advance in popularity wherever cheap fuel gas is available; and for many sorts of metal working the superiority of gas over solid fuel is well known.

The improvements which the gas-lighting companies have been forced to make through the competition of the electric light, have delayed the decline of gas lighting. It is altogether probable, however, that as the electric light becomes more and more universal, the use of gas for lighting will decrease. If this leads the gas companies to the successful introduction of fuel gas it will be an innovation which will work benefit to both the companies and the public.

CORRESPONDENCE.

The Newport News Drydock.

NEW YORK, May 25, 1891.

TO THE EDITOR ENGINEERING NEWS:

SIR.—The article in your issue of May 16 in relation to the fitting out of the yard of the Newport News Shipbuilding and Drydock Company bestows upon me praise which belongs to others.

Mr. C. B. ORCUTT, President of the company, has been prominent in the work done there, as well as the other gentlemen associated with him. They are the parties to whom the credit should be given. Yours truly,

HORACE SEE.

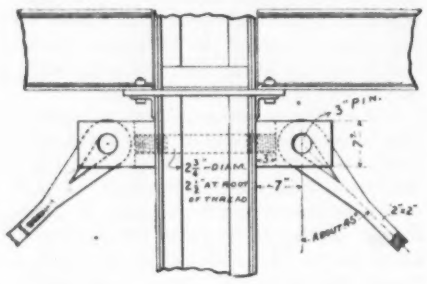
[We give place to the above letter with pleasure, feeling assured that, in acknowledging the doubtless very important services of his associates, we in no wise detract from the value of the recognized engineering ability of Mr. SEE himself.—ED. ENG. NEWS.]

Architectural Engineering.

CHICAGO, Ill., May 11, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I send you herewith a sketch of a connection I observed recently in one of the mammoth buildings now under erection in this city. It is probably self-explanatory, and I send it because I thought it peculiar when I



first saw it, and on calculation of the strains involved (based on the area of the loop-eye bar), derived such astonishing results that I wished to know more about it.

C. H. C.

[It is self-explanatory.—ED. ENG. NEWS.]

Engineering Positions Abroad.

TORONTO, Ont., May 6, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: You will notice from my card that I am a civil engineer and have been practicing my profession for a number of years. I am desirous of going to Mexico or South America, Brazil preferred, but do not care to go unless I can make definite arrangements before starting, in regard to work after getting there. I can give all needed testimonials as to my ability. My preference is municipal engineering, or corporation work, although I am not so very particular as to that. Can you put me in correspondence with parties who are interested in this way down there, or will you suggest my best plan of procedure to reach the desired end? As New York is the great trade center and the headquarters for almost everything, you are probably in a position to know of most of the movements to the countries mentioned. An early answer will oblige B.

[We receive many letters like this, which appear to be based on the idea that there is some halcyon region afar off where work can be had almost for the asking, or, at least, much more easily than here. There is no such region. The best places in the world for securing easy, profitable and continuous employment are within 500 miles of our correspondent's home. We always decline, therefore, in the interest of our correspondents, to give any general information of the character asked for, if, indeed, it would be possible to give it.—ED. ENG. NEWS.]

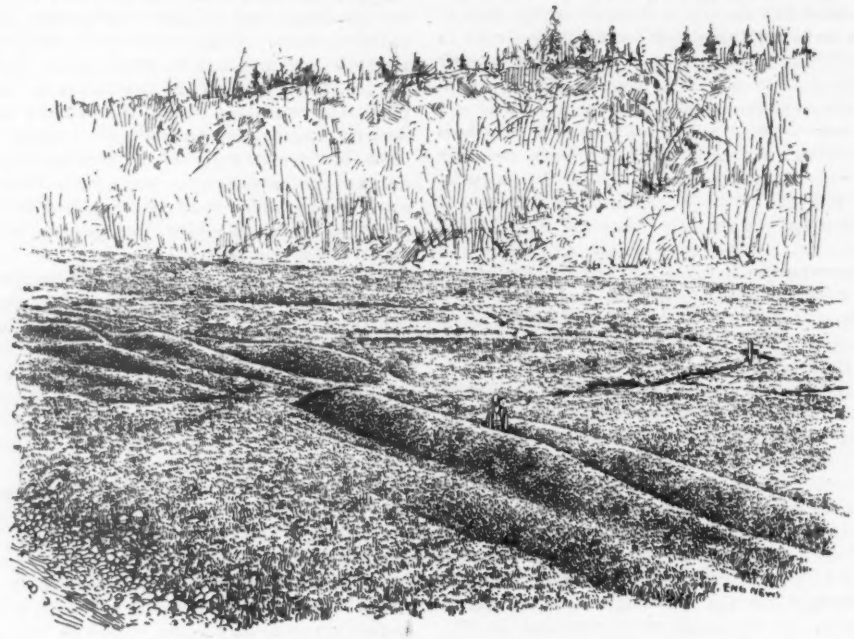
A Peculiar Effect From Filling on a Marsh.

NEW HAVEN, Conn., May 18, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In double-tracking the Shore Line Division of the New York, New Haven & Hartford R. R., we filled in a trestle at Lloyd's Island, Conn. The trestle was about 475 ft. long over a salt meadow, the track being from 18 to 20 ft. above it. The meadow was the ordinary salt meadow to be met with all along the shores of Long Island Sound. This particular one had a hard-pan bottom, 25 feet of mud and a grass topping. It was the peculiar action of this upper crust that I wish to note.

After the trestle had been filled in to height of 15 ft. or more small mounds began to appear on the meadow from 50 to 70 ft. from the track, and as we filled one after another appeared, until on both sides of the track the meadow was a succession of mounds from 50 to 135 ft. away from the track, and almost the entire length of the trestle, the meadow looking like a rolling sea, as shown in the accompanying view. The mounds were nearly parallel



Sketch (from a photograph) Showing Wavelike Mounds Formed by Filling a Railway Embankment on a Marsh.

The foot of slope may be seen at lower left hand corner of picture.

to the fill, and were from 25 to 100 ft. long, and from 1 to 5 ft. high.

At one time, by very careful watching, one could see the ground move.

The fill was made with great care, the weight being distributed as evenly as possible over the entire length. The settlement, however, would only take place in short sections at a time. I have filled in a number of these salt meadows, but never noticed the action of the top before. I send you herewith several prints which show quite well the appearance of the mounds. Yours, etc.,

C. M. INGERSOLL, Jr.

[We have never seen quite this effect, which must have been due to a comparatively tough skin of vegetation on a rather fluid subsoil. The skin then being ruptured under the fill, would be very likely to be pushed to each side in folds. Ordinarily the skin breaks.—ED. ENG. NEWS.]

"Canadian" and "American."

MONTREAL, P. Q., May 19, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: On page 461 of ENGINEERING NEWS of May 16 you say:

"Niagara Falls is to be set to turning water-wheels on the Canadian side as well as on the American."

Why is the Canadian side *not* in America, and why is a "Canadian" not an American! Etc., etc., etc. L. N. R.

[The Canadian side is in America, but not of it, in the broader sense, since it is a part of the British Empire; and the Canadian may be born on this continent, but is not formally of it, any more than the Englishman born in Hong Kong becomes thereby a Chinaman. As the Canadian glories primarily in his right to call himself a Briton (or is supposed to), he should not begrudge the term "American" to his brethren on this side of the line who have no other name to conjure by, and who are quite content with that. Of course, the root of the difficulty, against which Canadians struggle so bravely by using phrases like "United States men," etc., is that the term United States does not lend itself readily to the formation of an adjective, as does the word Canada.—ED. ENG. NEWS.]

Notes and Queries.

G. A. R.—The best slide rule is the Mannheim, sold by Keuffel & Esser, of this city, and probably by others. Its cost is about $5.

Some Methods of Meeting the Ordinary Requirements of Railroad Maintenance.*

The most frequent questions in maintaining a roadbed, while similar to those arising in new work, are at the same time somewhat different; because new work, especially at the West, is generally temporary in character, with trestles at all openings except large rivers, with a view to building permanent structures when better facilities exist for bringing stone, etc., from a distance, after the railroad has been opened. This seems advisable because it gives choice of better material at lower cost than if that nearest to each structure has to be used and hauled by teams, and also because it gives the engineer some years to form a judgment as to what size and kind of structure is really needed, with ample chance to note freshet level of water, etc., and thus to avoid useless expense in making culverts and bridges too large at first, and the contrary and greater danger of making them too small. Of course, the first desideratum is to get rid of every break in the solid roadbed which can be avoided, the saying that the best bridge is no bridge being certainly correct.

Taking a finished but temporarily built road as to structures, or an old road with structures to be rebuilt, and keeping in view the fact that a closed roadbed is desired, the questions to be answered before giving the master mason his orders as to work at any existing opening are:

First. Is it necessary to build anything, or can the opening be done away with altogether?

This is often possible if the opening has been reserved by a farmer for a cattle pass when the road was built, by paying him a small sum and perhaps providing a farm crossing at grade; though, as a rule, if any passage is to be kept open across the embankment, it is better to keep it under the track—a culvert—than to establish a grade crossing, unless the use would be but occasional and the cost of the culvert great. If, however, water has to be carried, or if right to close the cattle pass or driveway cannot be bought,—

Second. Can a stone box be built?

A box 4 × 6 ft. is ample for a cattle pass; and in general any size from a 2 × 2 ft. (the least size worth building) to a double 6 × 8 ft. can be built, as shown in Figs. 1, 2 and 3. If carrying water continually, or during 8 or 9 months in the year, foundations may be on timber, as shown in Fig. 1.

Even if the water is lacking for 3 or 4 months in the year it is found that decay does not occur. This is proved by the fact that canal abutments in this climate where water is absent for at least three months of each year have always been found to rest upon sound timber when exposed 40 or 50 years after their construction.

[The liberty thus given is to be availed of *with much caution*, however, and in general only when the foundations will be dry in winter only. When foundations and timber are liable to became thoroughly dry in summer experience shows that the timber will rot, and quite speedily. The present writer had a sad experience to that

* A lecture by Mr. A. J. SWIFT, Chief Engineer Delaware & Hudson Canal Co.'s R. R., Northern Dept., delivered before the students of the Rensselaer Polytechnic Institute. We have added a few notes where it appeared as if they might be useful.

effect, from overconfidence that there would be water enough to keep the foundations from rotting. Not much is gained by taking any chance, since if foundations do rot it is a serious matter.—ED.]

If rock can be found within 2 or 3 ft. of the level of the floor, of course timber should be omitted, as shown in Fig. 2, with or without stepped ends. If rock cannot be found, and, as in case of a cattle pass, no water is to be counted on or carried, the floor should be as shown at *A*, Fig. 3. If water is intermittent, but to be provided for with or without use as a cattle pass, it becomes advisable to pave, as shown at *B*, Fig. 3, slanting the flat paving stones away from the current. Wherever water is to be carried it is very necessary to protect *both* ends by sheet pile aprons or curb walls, as shown in Figs. 1 and 3. This is needed as much, if not more, at lower than at upper ends, because, if water is at all rapid and material soft, failure most frequently takes place at lower ends, as shown by the line of scour in Fig. 3.

A filling of large and small broken stone to carry this protection still further is desirable, and, in case of a rapid fall in the water surface, several cross walls to break the scour are often useful. Sheet piles can also be used instead of cross walls, if always wet.

[These remarks cover an important and much neglected matter. Our observation is that the protection is needed very much more at the lower end than the upper. Great carelessness is often shown in this respect, when great care should rather be used to carry the water safely away from the structure.—ED.]

All side walls should have a thickness of not less than 2 ft., or one-half the height, and covering 1 ft. or more thick should lap at least 1 ft. on them. When the width of the opening is greater than 4 ft., rails can be used, spaced about 6 ins. apart, center to center, under the roadbed, increasing to 2 ft. at ends of culvert. Spans up to 7 ft. may be thus carried under high banks, as shown in Fig. 4, and (dispensing with stone covering) up to 12 ft., with rails laid close and bolted together, when the bank is so low as to leave insufficient room for stone covering, as shown in Fig. 5. Any number of these rectangular openings side by side, can be used, and will be found economical up to an aggregate width of water-way requiring a considerable bridge span.

[It is to be noted that the proper thickness of the side walls of culverts depends very largely on the quality of the stone and stone work, and that except when both of these are good the above described side walls will be too thin. About 2½ ft., or two-thirds the height, is much safer. Some engineers would say more. We have never known any road to regret having made its walls so thick; many have had good reason to regret making them so thin.—ED.]

This latter form of rectangular culvert, Fig. 5, with an old rail cover, fills the field between the largest practicable span for a stone box, and that of insufficient height of bond for an arch. A covering of this kind with doubled rails is sufficiently strong and stiff for a clear span of 16 ft., assuming the use of rails 4½ ins. deep, weighing 70 lbs. per yd. By placing three wallplate rails on each abutment, a carefully leveled coping is rendered unnecessary, as a bearing on the masony at intervals of several feet is sufficient.

All box culverts are better laid dry, except end walls and curbs, if wide bedded stone laying to one inch joints are obtainable; and for a height of 4 ft. or more stepped ends are, it is thought, better than vertical parapet walls. To repair a box culvert is a common problem, and for this vitrified pipe, now made of double strength and thickness, or iron pipe are convenient, as they can be drawn through by means of a pilot or sledge timber under the end. But pipe is fully as expensive as a stone box in first cost, if not more so, and therefore seems not advisable for a new structure, unless the expense involved in obtaining suitable stone is considerably greater than the cost of the pipe. Pipes generally fail from uneven bearing or undermined ends, so that a bearing of longitudinal timbers and thorough protection of ends by apron or sheet piling (if generally wet) is advisable. The unavoidable leakage from the pipes generally makes the use of timber admissible, as shown in Fig. 6.

Repairs to box culverts of considerable size have also been made by converting them into partly oval openings by the use of granite paving blocks laid with fine Portland concrete in joints, as shown in Fig. 7, building in sections not more than 3 ft. long, and using wedge-shaped blocks, as far as possible, for the ring.

Third. Can an arch be built?

This, if practicable at all, should be of stone, because in time brick is sure to disintegrate from frost and infiltration. The objection to the use of an arch is generally lack of head room, since a section nearly semicircular is advisable, and it is necessary, in order to avoid disintegration of ring, to have at least 3 ft. of ballast. Thus, an arch of 16 ft. span for a single driveway would need to have at least 6 ft. bench walls, + 8 ft. versed sine, + 2 ft. voussoir ring, + 3 ft. ballast = 19 ft. of height; and a 24 ft. or double driveway would require 23 ft. of height. Specifications covering masonry, as ordinarily used, are given at the close of this article. It is generally found more economical to "axe" or "bush" the soffit or intrados than to try to economize by using a rougher finish, on account of the necessity for blocking from the centering to a uniform curve in the latter case. Foundations for an arch are generally to be built on the same principles as would obtain in those for an abutment. The limitation of height may often render two arches side by side advisable instead of one of greater span; but this is more expensive, of course, than a single arch of double the span.

An important question to settle is the length of the arch on the axis, and it is thought very advisable to build for the full width of slope, as at *F*, Fig. 8, and not try to shorten by using a parapet, as at *G*, Fig. 8, because an arch has no great *tensile* strength axially and failures are common from this cause on the line *X-X*.

This can be guarded against to some extent by stepped wing walls acting as buttresses, as shown in Fig. 8; but even with these it is thought very advisable to give the arch its full length. This is especially true on a single track road, which may sometime be double-tracked, as an increase of 4 ft. in height of parapet and wings, as dotted, then provides for a second track, and wing walls have to extend as far in one case as in the other. Nothing can be worse than the forms common in old arches, as shown in Fig. 9, with insufficient end walls failing as at *X-X*.

Of course an arch, or a series of arches, constitute the best class of engineering work, but their use is often limited by head room, as noted above, and also by the fact that two openings of say 20 ft. are not as available for passage of ice, logs, etc., as one bridge span of say 40 ft., or even less. Moreover, the expense of piers in a rapid stream for two or more arches is apt to be much greater, on account of coffer-dams and caissons, than that of abutments, so that these considerations have to be balanced against and often outweigh the professional feeling that an arch is the design to be preferred. It is not generally found to be economical or advisable to use sheeting less than 2 ft. thick for any span for which this is found suf-

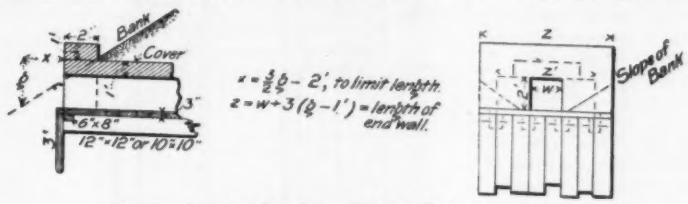


Fig. 1. Smallest Size Stone Culvert, Timber Foundation.

Fig. 3. Cattle Pass or Small Culvert.

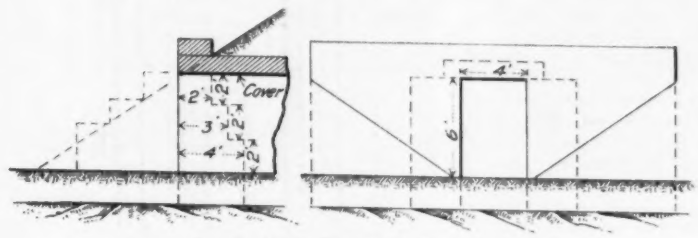


Fig. 2. Cattle Pass, Rock Foundation.

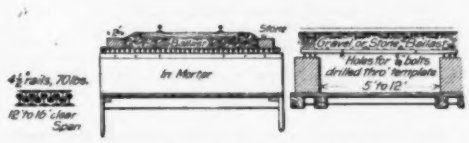


Fig. 5. Culvert without Stone Cover.

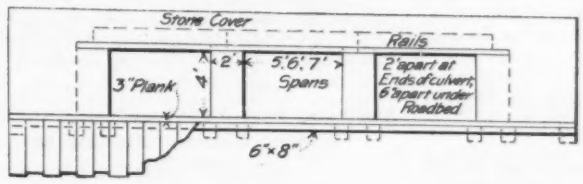


Fig. 4. Use of Rails for Supporting Culvert Covers.

Fig. 7. Arching a Defective Culvert.

Fig. 6. Pipe Culvert with Timber Bearings

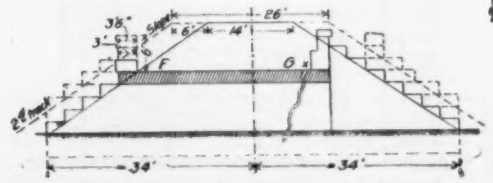


Fig. 8. Diagram Showing Disadvantage of Shortening Axial Length of Arch.

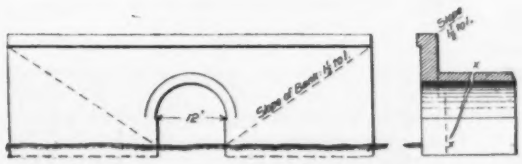


Fig. 9. Old Form of Arch with Insufficient End Walls.

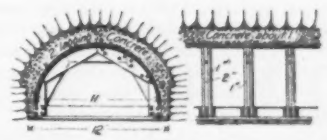


Fig. 10. Repairing a Defective Arch with Concrete

ficient by diagram or common formula, as given by Trautwine or Baker.

[This, we think, is too broadly stated; 15 in. to 18 in. ring stones are frequently used; but on all small arches, and especially those of less than 6 to 8 ft. span, rough rubble arches, well spalled and of good thickness, can be used to advantage and with good economy when the stone is naturally suitable.—ED.]

To repair an arch after failure from axial tension and by the opening of a crevice, noted above as the most common source of failure, the best and only method seems to be the removal of the parapet, lengthening the arch, and the construction of wing walls or buttresses.

If the arch stones have deteriorated and fallen out in addition to the above noted form of failure, there seems to be no remedy except to remove and rebuild the structure or to line the arch with fine concrete or beton. The Goodridge process of doing this is said to be very successful; but the expense is great. It can generally be done at comparatively small cost, as shown in Fig. 10, by using hinged centering and ramming the concrete or beton, mixed very dry, between the lagging and intrados of the old work, carrying this new material down past the bench work to the foundation and protecting its line of contact with the latter by angle iron, or, if under water, by plank. If two sets of centering are made in about 3 ft. lengths and the lagging is interlocked by alternate strips projecting, a smooth surface will be made for the soffit, one set of centering being left in place to support the green concrete while the other is moved in front of it and filled. Great expense in supporting track while excavation is made under it for a new arch can be saved by using this method; and the obstruction to traffic by slow flags, etc., is avoided.

(To be continued.)

The Comparative Merits of Various Systems of Car Lighting.

VI.

In order to afford opportunity for some further tests of the Frost dry carbureter plant, the publication of the remaining articles of this series is necessarily interrupted, but will be resumed as soon as possible.

The Metropolitan Sewerage Act for Eastern Massachusetts.

An act of the Massachusetts Legislature of 1889 provided for the construction of a system of sewage disposal for 18 towns and cities contiguous to Boston, appointed three commissioners to carry out this act, and the sum of $500,000 has actually been expended and contracts entered in to the amount of $1,418,000 in furtherance of the project. By the law the cost was to be paid first by the commonwealth, and then to be apportioned among the cities and towns named by a board of special commissioners appointed for this purpose by the Supreme Court. These cities and towns were then to pay in annual installments as the work progressed.

When the special commission of appraisers was to be appointed objections were raised by some of the towns against the constitutionality of the statute. Briefly stated, these objections were that—I. It involved a delegation of legislative power to these commissioners. II. It is in violation of the requirement that assessment and taxes shall be proportionate and reasonable. III. That no right of trial by jury is secured to the towns, as the assessment is to meet the cost of the work.

The original commissioners petitioned the court to determine these questions, and Mr. Justice CHARLES ALLEN has rendered an opinion fully sustaining the legislative action. The city of Somerville had complained that the law was unconstitutional, because the expense was not apportioned on all the inhabitants of the commonwealth. Stoneham claimed that it had no local sewers, and, therefore, would not be benefited. Winthrop argued against the bill because the state had already compelled it to build a sewer which emptied into tidewater.

As to the power of the legislature to appropriate money from the public treasury for this sewage disposal, the court cited the fact that such power already existed in the case of roads and bridges, and it will not do to contend that the benefit from such sewage disposal is purely local. The district to be benefited covers 130 sq. miles and one-sixth of the population of the state. The legislature, therefore, deemed this an object of public utility, warranting an expenditure from the treasury, and the court cannot say to the contrary.

As to whether the expense should be borne by the whole or a part of the people of the commonwealth, the court quotes the language of the constitution, which gives to the legislature full power and authority "from time to time to make, ordain and establish all manner of wholesome and reasonable orders, laws, statutes and ordinances, directions and instructions, either with penalties or without, so as the same be not repugnant or contrary to this constitution, as they shall judge to be for the good and the welfare of this commonwealth, and for the government and ordering thereof, and of the subjects of the same."

In this connection the court remarks that it is within the proper province of the Legislature to determine in this case where the burdens may rest. It may also determine that a part be assessed upon the commonwealth, or it may be wholly assessed upon the towns and cities, or wholly upon counties.

To the third objection that the cities and towns have no valid ownership in the sewers, the court answers that they have no absolute ownership in highways; and adds that it is beneficial to the towns not to have ownership, for otherwise they would be also responsible for negligence in their care.

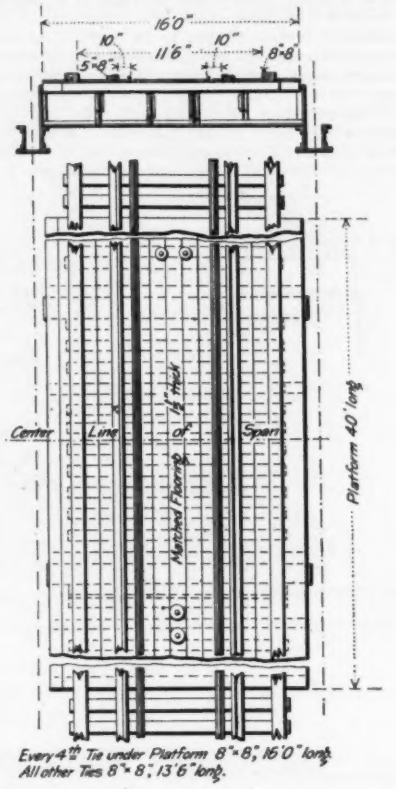
On the unconstitutionality of commissioners being appointed to determine the proportion to be paid by each town, the court does not sustain the objections. It is impossible for the legislature, or any other body, to lay down exact rules for guidance in this apportionment under the many conflicting conditions. These apportionments should be just and equitable under all the circumstances found to exist; and it is to be assumed that in the exercise of the discretion confided to the commissioners no rule of law or equity will be violated.

In the case of Stoneham, that has no local sewers saving a main drain, the remark is made that the town may need a system of local sewers before the general system is complete. The case of Winthrop is one for the commissioners to decide themselves, and is not taken into account by the court.

The Swing Span and Pivot Pier of the Coteau Bridge; Method of Floating Spans into Place.

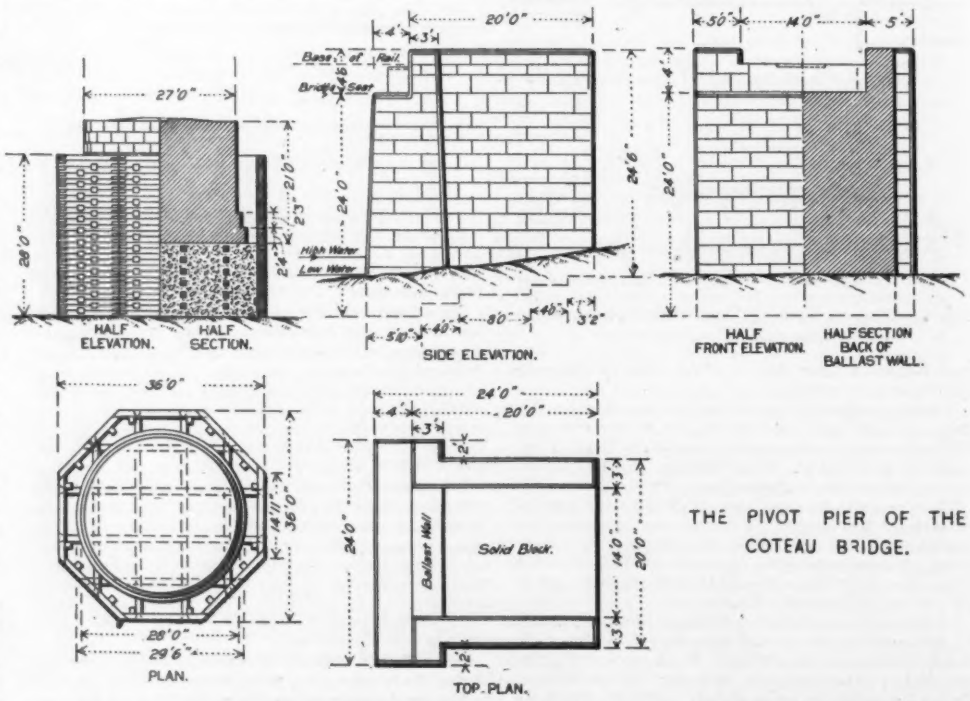
(WITH INSET.)

We are indebted to Mr. PHELPS JOHNSON, Chief Engineer of the Dominion Bridge Co., which had the contract for the superstructure of the Coteau Bridge, for the matter illustrated in the accompanying cuts and on our inset sheet for this week. A full description of the Coteau Bridge was given in our issue of April 12, 1890. The bridge was erected by the Canada Atlantic Ry. Co., to take the place of its ferry transfer across the St. Lawrence River from Coteau Landing to Clark's Island, about 27 miles west of Montreal. The total length of the bridge, including 2,000 ft. of trestle-work across Giroux Island and Isle-aux-Sienes, is 6,035 ft., or about 1⅛ miles. The foundations are of limestone masonry and the superstructure is of steel, the trusses being of the double triangular riveted lattice design. The average depth of the water is 34 ft., and the bridge seats are 17 ft. 6 ins. above mean water level. Work on the substructure was commenced April 1, 1889, and the bridge was completed Feb. 15, 1890.



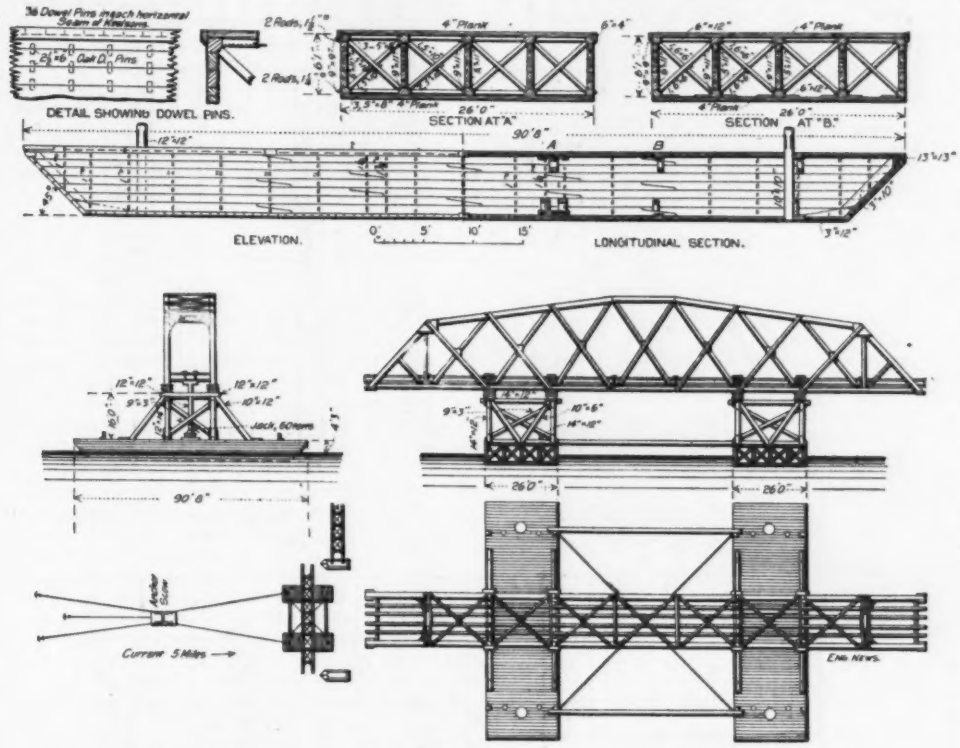
The Floor System of the Swing Span of the Coteau Bridge.

On our inset sheet we present the working drawings of the mechanism for operating the turn-table and end lifts of the draw span. This span is 255 ft. long and 16 ft. clear width between trusses. The machinery was designed by the engineers of the Dominion Bridge Co., and is to be operated by hand power. The design and mode of operation are clearly shown in the draw-



THE PIVOT PIER OF THE COTEAU BRIDGE.

ings. The power for operating the turning machinery is applied through a horizontal lever to a vertical shaft carrying a pinion, which gears into a horizontal spur wheel on the drum shaft. The drum shaft carries a shrouded pinion which engages with the horizontal gearing around the drum. The end lifts are operated by a similar lever and vertical shaft geared directly through beveled gears with horizontal shafts running to each end of the span, and gearing by transverse shafting at the ends into the pedestal feet, screwing up and down in the



BARGES USED TO FLOAT SPANS OF COTEAU BRIDGE INTO POSITION.

pedestal frames. The dimensions of the various details are shown on the inset sheet.

The cuts accompanying the text give the details of the pivot pier and the floor system of the draw span, and show the construction of the barges and the manner of floating the spans into place. The drawings largely explain themselves.

The mode of placing the spans was as follows: The trusses were erected on false works of the same elevation as the bridge. The two scows were lashed together 70 ft. apart, and sunk about 2 ft. by admitting water through valves provided for that purpose. They were then floated underneath the trusses, the water was pumped out and the barges rose, lifting the trusses from the false-work. The scows and span were then towed to the bridge site, placed in position and water admitted, settling the scows and leaving the span in place upon the piers. Sixteen of the 18 spans in the bridge were floated into place in this manner. In this connection Mr. PHELPS JOHNSON writes us as follows:

Spans have been floated into position before, but so far as I know this has always been done at locations which did not admit of erection *in situ*. In this case there was no insurmountable difficulty attending trestling the channels, but the staging would have been hard to set, would have been expensive, and as the bridge is just at the foot of a long lake, would have been exposed to severe storms, and there would have been great danger of its shifting upon the smooth rock bottom in one of the channels. Under the circumstances, and considering the large number of spans to be handled, I decided to float them into place, and the work was very successfully done, the 14 spans of the South and Middle channels having been placed in 42 days. Eight of these spans were, however, fully erected and riveted before the work of floating started.

The novelty of this case consists in the mode of erection having been chosen on the score of economy and safety in the large number of spans that were handled, and in the provision of storage room for quite a large number of spans at the place of erection, the spans being assembled and riveted on staging built on shore and then shoved sideways on two piers extending out into the water, where they were stored until taken off on to the scows and towed to the location of the bridge. The construction of the scows and the manner of handling them are pretty plainly shown by the drawings.

Mr. JOHNSON also writes us that the seven spans of the bridge recently completed at Grand Narrows, N. S., by the Dominion Bridge Co., were erected in the same manner. The water at this point is about 75 ft. deep and has a surface current of about 5 miles per hour with the tide. The swift current, together with small elevation of the bridge above the water, would have made the sinking of false works very difficult. All the spans were floated without accident. The time occupied in floating a span into place was usually from 3 to 4 hours, and in one case two spans were placed in one day.

Chicago in 1891.

From the late annual message of DE WITT C. CREGIER, Mayor of Chicago, some facts may be gleaned concerning the growth of this wonderful city, which was originally incorporated only 55 years ago. Since the first incorporation there have been 10 annexations of territory, and 9 of these, adding 140 sq. miles, have been gathered to the city within the past 2 years. The city limits now extend 21⅛ miles north and south, and 10⅛ miles east and west at the widest point, and 4⅛ miles at its narrowest part. The total area within the city limits is now 181⅛ sq. miles, or 116,000 acres.

The bonded debt of the city is $13,545,000, bearing interest from 3½ to 7%. Annexation has added nearly one million of this. During the next two years $5,000,000 4% bonds will be added to meet the demands of the World's Fair.

There are now 2,300 miles of streets in this city, 1,250 miles of water mains, 12,000 fire hydrants, 154,000 water taps, and 785 miles of sewers. Last year 108 miles of new pavement were laid and nearly 250,000 sq. yds. relaid, 433 miles of sidewalks were laid, 7,137 miles of streets cleaned, and 133 miles of new water mains laid, costing $1,250,000. The water-works of the city have cost in all nearly $17,000,000. The aggregate receipts for water have been about $25,000,000, and the net water receipts $8,000,000. In 1890 the revenue from water was $2,267,000. The new works under construction will increase the capacity to 24,000,000 galls. daily.

The death-rate during 1890 was 18.22 per 1,000, and of the total, 21,856, nearly one-half were of people under 5 years of age. Within four months over 100,000 people suffered from influenza, or *la grippe*.

The fire department has 914 men, 209 engines and vehicles, 22 miles of hose, 89 fire stations and 387 horses. There were 4,639 alarms and 3,459 fires in the year.

There are 1,680 effective policemen, and 1,900 men of all grades in the department. This department has 163 horses, 38 patrol wagons, 25 carts and buggies, 33 police stations and 654 patrol boxes.

Chicago has 218 school buildings, with a seating capacity of 125,000, and an enrollment of 139,000 pupils. The city spends $5,500,000 annually on the day schools and $70,000 on night schools. Over 1,250,000 books were issued in 1890 from the public library.

In 1890, 11,640 buildings were constructed, costing nearly $48,000,000. The estimated number of buildings in the city is 150,000.

Free Railway Construction vs. Governmental Railways.*

Under the head of Free Railway Construction will be included all railroads that have been or can be built by individuals or companies without special acts of government, whether national or State. Under the head of Government-Owned Railways will be included those owned and operated by the government; and under the head of Government-Controlled Railways will be included all those that cannot be built without a special act of government, as is the case with all English railways; in these the English Government has no direct or indirect ownership whatever, but owing to the great difficulty and cost of getting from Parliament special acts to build new lines of railways, the present English roads have a virtual monopoly of the land transportation of the United Kingdom. It is needless to say that the roads make the most of this exclusive right, by charging freight rates that to Americans appear excessive, half of which would fill the hearts of our railroad managers with joy.

All that can be said in favor of government ownership or control of railways is, that it can regulate the freight charges and prevent excessive rates that would interfere with the industries of the country. Practically it has no such effect, the highest railway freight rates in the world are in England and her colonies, where the railways are either owned or controlled by the government, and the lowest rates are those in the United States, where there is free railway construction, and consequently great competition which has obliged our managers to build and operate their railroads upon the most economical plans, and to adopt all new inventions that will reduce the cost of construction or operating expenses. This has made it possible for them to transport freight over inferiorly constructed roads at less than half the English cost.

The following table shows some of the current freight rates in England, South Africa and the United States:

£1 = $4 80.	Miles of Haul.	Freight Charge Per Ton Per Mile.		
		England.	South Africa.	United States.
		Cts.	Cts.	Cts.
Birmingham to London, hardware	113	*a* 5.85	.....	.....
Birmingham to Manchester, hardware	90	*a* 5.73	.....	.....
Stoke-on-Trent to Liverpool, pig iron	55	*a* 2.32	.....	.....
Birmingham (U. S.) to Pensacola pig iron	280	.....	.....	*b* .50
Birmingham (U. S.) to Pensacola, coal	280	.....	.....	*b* .50
Merthyr (Wales) to London, coal	177	*a* .995	.....	.....
London to Oldham, cotton	188	*a* 2.56	.....	.....
Liverpool to Oldham, cotton	43	*a* 5.10	.....	.....
Cape Town to Kimberly, grain (domestic)	647	.....	*b* 3.	.....
Cape Town to Kimberly, iron	647	.....	*b* 7.	.....
Port Elizabeth to Kimberly, grain (domestic)	485	.....	*b* 3.	.....
Port Elizabeth to Kimberly, grain (imported)	485	.....	*b* 6.	.....
Cape Town to Kimberly, grain (imported)	647	.....	*b* 6.	.....
Port Elizabeth to Kimberly, iron	485	.....	*b* 7.	.....
Durban to Biggarsberg—Natal, grain	231	.....	*a* 8.	.....
Durban to Biggarsberg—Natal, iron	231	.....	*a* 9.25	.....
Newcastle to Durban—Natal, coal	270	.....	*a* 1.50	.....
Average charge for all freight on Pennsylvania Railroad Division. Average haul	135	.....	.....	*b* .026

NOTE.—*a* = ton of 2,240 pounds. *b* = ton of 2 000 pounds.

The railway from Durban has many grades of 3⅛%, and one summit of 5,155 ft. above its initial point. The first part of the road is very badly located for cheap working. Coal

* Abstract of a paper by Mr. E. BATES DORSEY read before the American Society of Civil Engineers' Convention at Lookout Mountain.

on the railways from Port Elizabeth and Cape Town costs from $8 to $12 per ton. All the railways in South Africa are owned and operated by the colonial governments; they are very well constructed and maintained, much better than the average of our American roads.

In a former paper read before the society the author compared the London & Northwestern Railway of England to the Pennsylvania Railway Division of the United States. The comparison is here continued down to the year 1889:

Average cost of transporting one ton or one passenger one mile, £1 = $4.80.	London & Northwestern.		Pennsylvania R. R. Division.	
	1884.	1889.	1884	1889.
	Cts.	Cts.	Cts.	Cts.
Maintenance of way	.209	.208	.103	.089
Repairs, renewals of locomotives	.062	....	.044	.034
Total cost of motive power	.271	.286	.118	.130
Total operating expenses	1.130	1.205	.530	.491

This shows that in the last five years the total operating expenses of the London & Northwestern has increased 7%, while that of the Pennsylvania has decreased the same percentage.

In comparing American railways with those of Europe, the usual mode of comparison between the cost of train miles is misleading and erroneous, owing to the great difference in the train load of paying freight, which is only 59 tons on the Great Northern of England; the general average of all the railways of the United Kingdom being 71 tons—less than half of the average paying load of the American trains. It is like comparing the cost of a donkey cart with that of a six horse wagon.

Much has been said of the great advantage the American railways have over the English in their long freight haul; this argument is entirely false, as the average receipts per ton on the English roads are about the same as those on the American, the only difference being that the American hauls the freight more than three times the distance for about the same money. For example, the average haul of the Pennsylvania Railroad Division is 135 miles, with average receipts per ton of 85 cts.; on the London & Northwestern Railway of England the average haul is about 35 miles, and the average rate per ton 81 cts. The author can see no advantage of the long haul in this case.

The severe competition between railways in the United States is undoubtedly very bad for the shareholders, but it has been the making of the country. Suppose we estimate the sphere of beneficial influence to extend 12 miles each side of the line; this gives 15,360 acres of land for each mile of the road; estimate this at $20 per acre, and it makes the total valuation of the land benefited by the railway $307,200, while the cost of the mile of railway is, say, $30,000, or 10 per cent. of the value of the land benefited. The appreciation in the value of the land is very much larger than the cost of the railway, and the investment would pay even if the entire cost of the railway was lost.

The leading English railways pay the following dividends on their ordinary shares:

	Per cent.	
	1888.	1889.
London & Northwestern	7⅞	7⅞
Midland	6	6
Great Northern	4⅞	4⅞
Great Western	6¾	6¾
London & Southwestern	6	6
Taff Vale	5	5

This shows that the English railways pay very well when their great cost is considered, but the money is undoubtedly earned at the expense of home industries.

In English South Africa all the railways are owned by the government, and the evil effects of the state ownership can be readily seen. In order to get the necessary votes in the assembly to pass a bill authorizing the construction of meritorious lines it has been necessary to build other lines that were not required and will not pay. To secure the required votes they must make an omnibus bill, including the different railways proposed; following there in their railway bills the same practice that we do in our river and harbor bills.

As an example of this, the Cape Colony government railways of South Africa, operating 1,599 miles, which cost $14,282,766, earned in 1889 a net profit equal to a dividend of 5¾ % on the total cost. The road from Port Elizabeth to Kimberly, a part of the system, 485 miles long, costing £4,300,000, earned in the same year 13¾ % on its total cost. This branch transported large quantities of mining machinery and goods to the interior for the diamond and gold mines, and shows the remarkable receipt of over $17 for each ton of freight handled, which the author believes to be unequaled on any other road.

As the government and railway officers wish to make a good financial showing, they are obliged to charge high freight rates on the good lines to make up for the loss on the poor ones. This has caused such high freight rates as to be nearly prohibitory to farming except near the seacoast. Diamond and gold mining, sheep and ostrich farming are the only industries developed in the interior that an stand the high freight charges. The government will not grant permission to construct private lines, for fear of competing with and injuring the public lines.

Many reasons, such as republican government, free government, free religion, rich soil, etc., have been given as the cause of the great prosperity of the United States; but the real cause has been the law allowing free railway construction. This has given the country much greater railway facilities than it could have had otherwise, and the sharp competition has given such low freight rates, that the interior of the United States, notwithstanding its thousand miles of railway freight, can compete successfully with Europe in its food products.

If there was free railway construction in the United Kingdom, with new roads built and run also, according to modern railway practice, these would by competition force the old roads to improve their rolling stock, and consequently reduce largely their operating expenses, thus enabling them to make large reductions in their freight charges, without interfering with their dividends.

If those who are working for state interference, control or ownership of railways, in order to reduce the freight charges, should travel and see what is being done in other countries, where the railroads are more or less controlled by the government, they would return convinced that railway facilities and freight charges in the United States, under our free railway construction laws, are by far the best and lowest in the world. They should look into the financial condition of the offending road, when, if they can show large or excessive profits, it would be very easy to obtain capital to build competing lines—promoters and contractors being constantly on the lookout for such opportunities. The most dissatisfied granger cannot say that our railways are now paying unreasonably large dividends.

The author, after long and close observation in other countries, is of the firm conviction that the best way to reduce freight rates is to have free railway construction and its consequent competition; as it will give cheaper rates and greater facilities than can be had under government-controlled or owned railways.

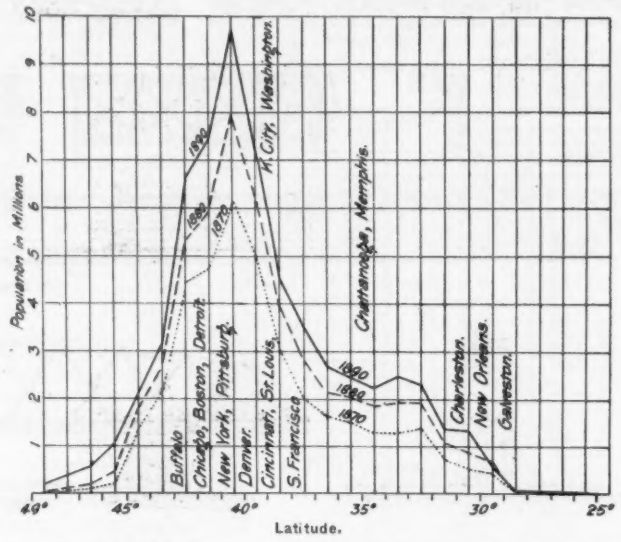


Diagram Showing Distribution of Population Along Parallels of Latitude in the United States.

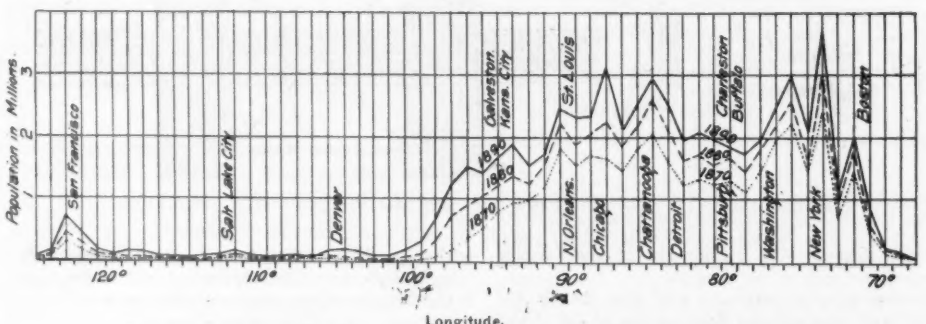


Diagram Showing Distribution of Population Along Meridians in the United States.

Distribution of Population by Latitude and Longitude.

The two accompanying engravings reproduced with some additions and changes from Census Bulletin No. 63, show the total population of the United States along each degree of latitude and longitude in 1870, 1880 and 1890, and hence show very clearly to the eye about how our population has been and is distributed. To prepare the diagrams the population of each square degree is first determined from the census records, whence the rest followed easily. To make the diagrams more readily comprehensible, we have added the names of all our larger cities in their proper geographical position.

Naturally the greater density of population in a square degree is greatly affected by the location of the larger cities. Thus the two square degrees between latitudes 40° and 41° and longitudes 73° and 75°, comprising New York, Brooklyn, Jersey City, and the other neighboring large cities, contain 3,653,000 inhabitants. The square degree between latitudes 42° and 43° and longitudes 71° and 72°, comprising Boston and its suburbs, has 1,233,000 inhabitants; that between latitudes 39° and 40° and longitudes 75° and 76°, in which is most of Philadelphia, has 1,414,000, while that between 41° and 42° and longitudes 87° and 88°, in which is situated most of Chicago, contains 950,000 people.

The bulletin is accompanied by full tables of population, density and percentages of increase, which we need hardly reproduce as respects longitudes, but the percentages as respects latitudes will have some interest and are as follows:

Cities.	Degrees of latitude.	Population in thousands.			Per cent. of increase.	
		1890.	1880.	1870.	1880-'90.	1870-'80.
	48-49	144	17	6	747.1	183.3
	47-48	388	79	30	391.1	163.3
	46-47	547	215	84	154.4	156.0
	45-46	1,064	483	249	120.3	94.0
	44-45	2,134	1,768	1,354	20.7	30.6
	43-44	3,236	2,678	2,197	20.8	21.9
Buff., Detroit	42-43	6,655	5,358	4,485	24.2	19.5
Chic., Bost'n	41-42	7,506	5,938	4,716	26.4	25.9
N. Y., Pittsb	40-41	9,832	7,863	6,177	25.0	27.3
Denver	39-40	7,284	6,265	4,994	16.3	25.5
St. Louis	38-39	4,606	3,966	3,129	15.3	27.7
San Francisco	37-38	3,528	2,531	2,017	24.6	40.4
	36-37	2 660	2,170	1,644	22.6	32.0
Chattanooga	35-36	2,490	2,078	1,594	19.8	30.4
	34 35	2,229	1,805	1,282	24.0	40.8
	33-34	2,503	1,940	1,291	29 0	50.3
	32-33	2,382	1,939	1,383	17.7	40.2
Charleston	31-32	1,362	1,060	747	28.5	41.9
New Orleans	30-31	1,343	865	595	55.3	45 4
Galveston	29-30	602	673	505	a10.5	33.3
	28-29	109	61	39	78.7	56.4
	27-28	61	36	18	69.4	100 0
	26-27	22	21	12	4.8	75.0
	25-26	7	9	6	a22.2	50.0
	24-25	19	8	4	137.5	100.0

Building Roadways Over Peat-bogs.

In an article upon this subject by M. SCHACHT, and abstracted in the "Papers" of the Institution of Civil Engineers (Vol. civ, part ii), the following advice is given concerning the construction of highways over peat-bogs: An undrained moss consists of about 90% of water and 10% of vegetable matter, and,

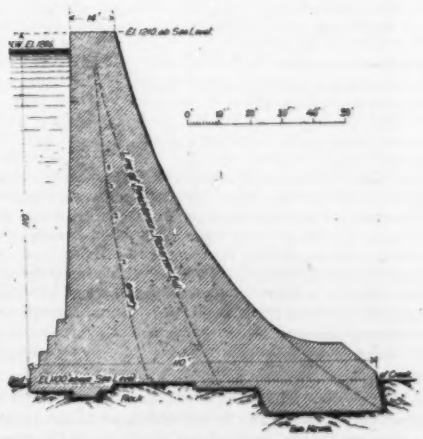
consequently, while in that condition is quite incapable of sustaining a roadway. By gradual drainage, however, the fluid mass is condensed into a more or less dense peat, but it is of great importance that this should not be attempted to be effected, at too rapid a rate, as there is a liability of the escaping water carrying off with it the particles of vegetable matter, causing the sides of the ditches to collapse and the production of fissures on the surface of the moss, which, becoming filled with water and ice in winter, extend more and more.

The drainage of the strip of moss along the site of the intended roadway should be effected by side-drains, carried gradually down and into the solid underlying ground, and if this can be done it is probable that the moss by conversion into peat will be reduced by about one third o. its total thickness. It is recommended that in making the drains the sides, instead of being sloped, should be cut in a series of steps or benches, each of about 3 ft. 3 ins. deep and 3 ft. 3 ins. broad down to the requisite level, so as to expose as large a surface as possible to the influence of wind and sun, and thereby produce a comparatively hard skin of dry peat, and consequently lessen the destructive action of frost.

Supposing it be required to make a roadway of 10 metres (32 ft. 9 ins.) broad, across a moss of 6 metres (20 ft.) in thickness, it is recommended that, to begin with, a surface of 1 ft. 8 ins. to 2 ft. 6 ins. broad and deep should be cut parallel with the center line of the roadway, and at a distance of from 36 to 46 ft. on each side of the axis, depending upon the width of the cess (viz., from 6 ft. 6 ins. to 16 ft. 6 ins.), which it is intended to leave between the edge of the roadway and the side drain. At right-angles to these and across the roadway similar drains should be cut about 32 ft. 9 ins. apart, extending laterally across and beyond the side drains, and from 130 to 160 ft. long. The excavation from these drains should not, however, be deposited near their edges, or slips will probably occur, but laid on the roadway site, as it will have to used for refilling the cross-drains later on. This work having been executed in the first summer, during the next season all drains can be deepened to the extent of a further 1 ft. 8 ins. or 3 ft. 3 ins., and the sides, in the case of the longitudinal drains, widened 1 ft. 8 ins. (½ metre) or more. In the third year all the drains can be further deepened in like manner, care, however, being taken to keep the transverse drains crossing the road site as narrow as possible.

A matter of the greatest importance is to prevent the formation of fissures longitudinally on the site of the roadway, transverse fissures being of but little importance. The foregoing forms only the preliminary process of drainage, and it must depend upon the nature of the moss as to whether four, five or more years will suffice for bringing into a condition sufficiently solid to allow of the forming of the roadway, composed of sand, etc., topped with metalling.

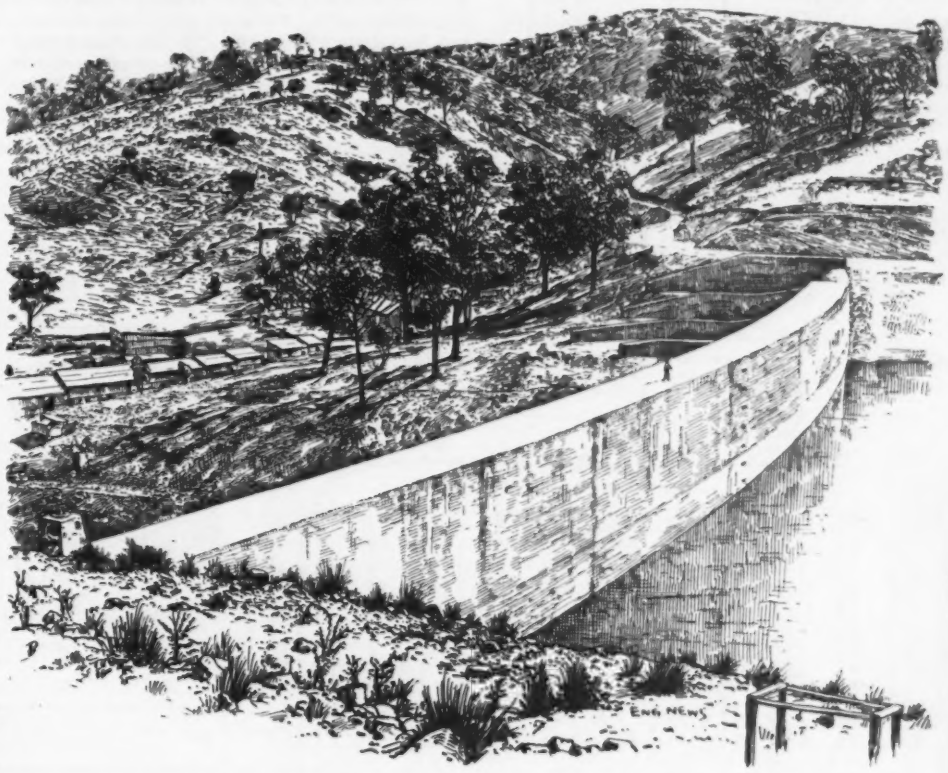
The author refers to the remains of Roman causeways which are discovered occasionally at a depth of from 3 to 6 ft. below the surface of some of the mosses in Northwest Germany. They are formed of longitudinals of rough-hewn timber, overlaid by transverse timbers of lighter scantling.



SECTION OF BEETALOO DAM.

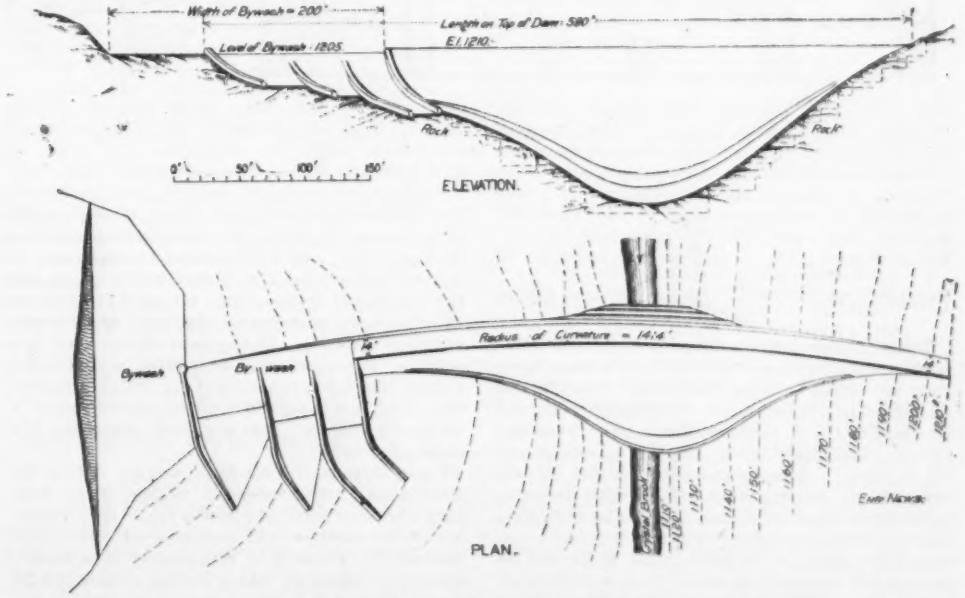
The Beetaloo Dam, South Australia.

We are indebted to Mr. A. B. MONCRIEFF, Mem. Inst. C. E., for the accompanying illustrations and description of the impounding dam for the Beetaloo head-works, South Australia. The reservoir formed by the dam has a capacity of 800,000,000 imp. galls., and stores water for the irrigating and domestic supply of 1,715 sq. miles, including several towns.



VIEW OF CONCRETE DAM, BEETALO WATER-WORKS, SOUTH AUSTRALIA.
Alex. B. Moncrieff, Engineer in Chief.

The accompanying plan, elevation, section and view give a good idea of the structure, its dimensions and surroundings. The dam is 580 ft. long, 110 ft. high, 110 ft. thick on a level with the bed of the creek and 14 ft. thick at the top. The cross-section is in accordance with Prof. RANKINE's formula, the horizontal curvature having a radius of 1,414 ft. The structure is founded on rock and has a spillway 200 ft. long by 5 ft. deep, its channel below being divided by walls into 3 sections, as shown by the drawings.



ELEVATION AND PLAN OF BEETALOO DAM.

Water is distributed from the reservoir by means of 255 miles of mains from 18 to 2 ins. in diameter. The pipes were of local manufacture.

The dam is of concrete. Its construction was begun in 1888 under the direction of Mr. MESTAYER, Mem. Inst. C. E., then engineer, and with Mr. HOBSON, Assoc. Inst. C. E., as resident engineer. In May, 1888, Mr. A. B. MONCRIEFF became Chief Engineer, and has remained in that position since.

The dam was completed in October, 1890, having been under construction about 2½ years.

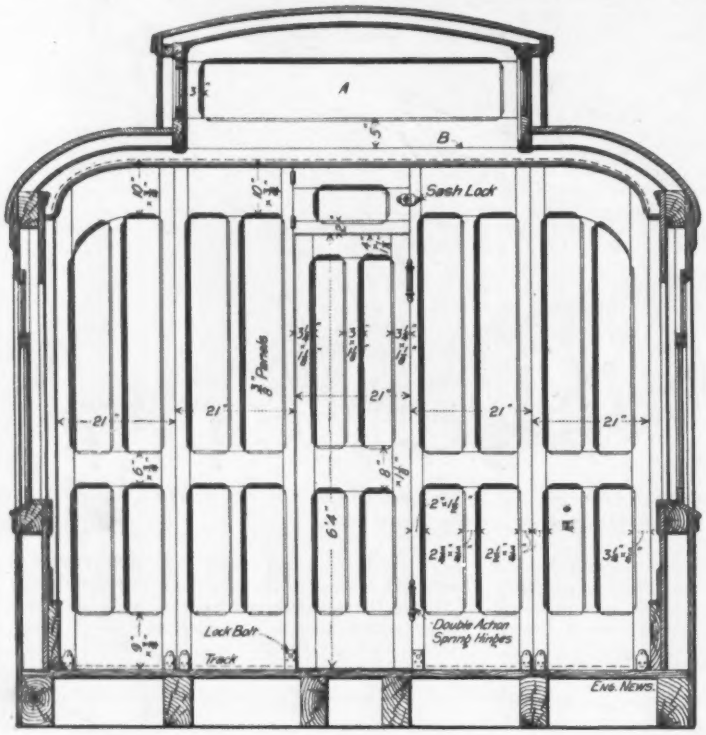
When full the reservoir will be about 1¼ miles long and have an average width of about 530 ft. At the dam the water will be 105 ft. deep.

The stone and sand used in making the concrete were obtained in the neighborhood, but the cement was imported from Europe. Machinery was employed in mixing and depositing the whole of the concrete, of which 60,000 cu. yds. were used. The dam cost about $570,000.

Portable Partition for Railway Cars.

The Texas Legislature recently passed a law compelling railways in that state to furnish separate car accommodation for negro passengers, and in order to comply with this law the railways have adopted a portable partition which was designed for the purpose by Mr. W. P. SIDDONS, Superintendent of Car Department, International and Great Northern R. R. The general arrangement of this device is shown below.

Two stationary transoms, *A*, are put in the clear-story of the car, and fastened to each is a grooved molding, *B*, conforming to the shape of the lower deck. The top of the partition fits into this groove, and the bottom is fitted with brackets sliding on a V-shaped track, fastened to the floor of the car. There are six of these brackets, and two additional brackets with lock bolts fasten the bottom at the aisle, as shown. The track and brackets and the molding *B* are shown in detail in Fig. 2. The partition is made in four vertical sections, to one of which is hinged the door header, which serves to keep the top firmly in place. There are two tracks in the car, one under each of the permanent moldings, so that a compartment one-quarter or one-half the length of the car may be partitioned off.



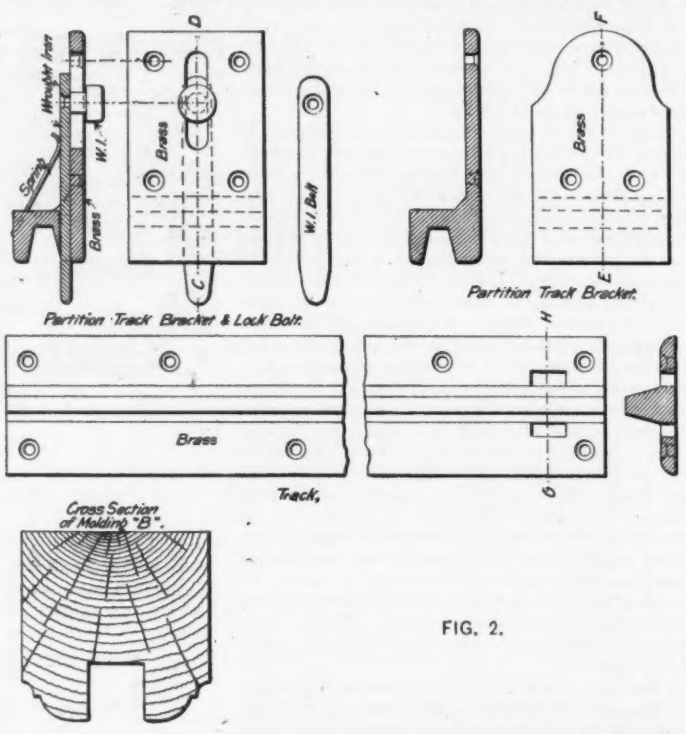


FIG. 2.

Battle Ships for Coast Defence: United States Navy.

Three heavy battle ships for coast protection service are to be added to the United States Navy. Two are being built by the Cramp Ship Works, Philadelphia, Pa., at a cost of $3,020,000 each, and the third by the Union Iron Works, San Francisco, Cal., at a cost of $3,180,000. The leading dimensions are as follows: Length on water line, 348 ft.; extreme beam, 69¼ ft.; draft, 24 ft.; displacement, 10,200 tons. They will have engines of 9,000 HP., giving a maximum speed of 16.2 knots, and a sustained sea speed of 15 knots. The hulls will be protected by belts of 18-in. armor, 7½ ft. wide (extending 3 ft. above the water line), turned in forward and aft to protect the bases of the armored redoubts. Beyond this, at the ends, will be under-water protective decks, 3 ins. thick, sloping at the sides to 4½ ft. below the water line. There is also a 2½-in. armored deck over the belt. Over the belt deck are placed the coal bunkers, and belts of water excluding material are placed on the slopes of the end protective decks. Above the belt armor and extending between the redoubts the sides are protected by 5 ins. of steel. At each end of the armored belt are the redoubts of 17 ins. of armor, extending 3½ ft. above the main deck, and giving an armored freeboard of 15 ft. 2 ins. These redoubts protect the turning gear and loading machinery of the turrets, which have inclined sides 17 ins. thick or 20 ins. thick horizontally. The side armor belt is backed by 6 ins. of wood, two ¾-in. steel plates and 10 ft. of coal. The 8-in. guns have 10-in. barbettes and inclined turrets 8½ ins. thick, on conical bases. The 6-in. guns have 5 ins. of armor and 2-in. splinter bulkheads. The six-pounder guns have service shields, and also 2 ins. of armor where mounted between decks. The one-pounder guns are protected by 2 ins. of steel.

The armament consists of four 13-in. breech-loading rifles of 35 calibres, two of which are mounted in each turret; eight 8-in. and four 6-in. breech-loading rifles, 20 six-pounder and 6 one-pounder rapid-fire guns, and 2 Gatling guns. The weight of armament is said to be superior to that of any of the latest battle-ships designed by foreign powers. The 13-in. guns are 17 ft. 8 ins. above the water line, and the 6 and 8-in. guns 14 ft. 10 ins. and 24 ft. 9 ins. above the water. Great care has been taken in arranging the guns to give large arcs of fire. There is a fixed torpedo tube at the bow and another at the stern, and on each side are two training tubes 5 ins. thick, through which to discharge torpedoes. The ammunition supply is well protected, and will be rapid in operation. A conical military mast is placed well forward, and fitted with two armored tops for rapid-fire and machine guns, the ammunition supply for which is sent up inside the mast. At the base of the mast is a conning tower, protected with 10 ins. of armor, and a large pilot-house is provided for ordinary service use. The bow is built into a ram, and the stern is outwardly inclined from the deck, protecting the submerged rudder.

These ships will have twin screws, driven by direct-acting, triple-expansion engines of the ordinary marine or inverted cylinder type. Each engine will be in a water-tight compartment. The cylinders are 34½, 48 and 75 in. diameter, all 42-in. stroke. Each main condenser has a cooling surface of 6,353 sq. ft. Powerful wrecking pumps are fitted in the donkey boiler rooms, and independent centrifugal circulating pumps are provided. Steam is furnished by four double-ended main boilers and two single-ended auxiliary boilers, all of steel and of the horizontal return tubular type. All main boilers will be 15 ft. diameter and 18 ft. long, each having eight corrugated furnaces 3 ft. diameter. The total heating surface is 17,400 sq. ft., and grate area 552 sq. ft. The auxiliary boiler will be 10 ft. 2 in. diameter and 8½ ft. long, having a heating surface of 1,937 sq. ft., and a grate area of 64 sq. ft. The are two smokestacks. Boiler pressure, 160. The bunkers have a capacity for 1,800 tons of coal, or enough to give the ship a steaming capacity of 16,000 miles at 10 knots. Fans driven by steam are used for the exhaust ventilation of engine and boiler rooms, coal bunkers, etc. Electric motors are used for ventilating the living quarters, and a complete system of drainage by steam and hand pumps is fitted. The equipment includes an electric light plant and electric search lights. The bed-plates of the engines are 25 ft. 6 ins. long and 8 ft. 6 ins. wide. Height from bottom of base plate to top of cylinders, 18 ft. These ships are now under construction, and are to be named the Massachusetts, Indiana, and Oregon.

Iron and Steel Works in China.

From recent papers received from China we learn that some progress is being made in the erection of iron and steel works in that country. After much delay and discussion a site has been chosen on the northern slope of the Hanyang Hills, between the ridge and the Han River, opposite the city of Hankow, and thus close to the Yangtze, with which afterward the works will be connected. It is understood that the works will comprise for the present two large blast furnaces of the Cleveland type, with all their appliances and machinery, and capable of producing about 100 tons of pig iron daily. There will also be a complete Bessemer plant, including two 5-ton converters, with cupolas, casting cranes, blowing engines, etc. The rolling mills are specially adapted for the production of rails; in fact, the chief object of the Chinese in designing these iron and steel works has been the supplying of material for their future railway system. They have, however, added a small Siemens-Martin steel plant, chiefly for the object of casting soft steel for ship plates and special metal for the Viceroy's small arms and gun factory. The malleable iron department will be tolerably complete, including some 20 puddling furnaces and a plate and bar mill, with all indispensable machinery. It is roughly estimated that the works will cover about 40 acres. The most of the blast furnace plant has already been delivered, and the contract requires that the whole of the plant must be delivered in the first month of next year.—*Industries.*

A HOT-WATER ARTESIAN WELL is in operation at Boise City, Idaho. The water company of that place has now two wells, each about 400 ft. deep, discharging over 1,000,000 galls. per day of water said to have a temperature of 180° Fahr. Another well is to be bored, and this hot water is to be utilized for bathing purposes and for a large hotel to be built near the wells.

THE ILLUMINATION OF LIGHTHOUSES has been lately a subject of investigation by a special committee in England, and in a general way it has been proven that electric light is not so well adapted to the purposes intended as certain oils and gas. Following on the report of this commission a burner is now on exhibition before the Royal Dublin Society, by which gas from ordinary coking coal is

so enriched by hydrocarbons and heated air as to produce an illuminating power about double that of the most powerful gaslight used in lighthouses. Another device before the same society is a new arrangement of dioptric apparatus by which lenses of larger surface and greater focal distance than those at present adopted can be used. The inventors claim that by a combination of the two devices an 8,000,000 c. p. light could be produced—a light six times as powerful as the Torry Island light, the largest flash light in the world.

THE NEW YORK AND NEW JERSEY BRIDGE CO. announce that they expect to commence the construction of their bridge over the Hudson River on Sept. 1 next, and also say that they have secured $1,000,000 of the $40,000,000 capital with which to commence work. This is Judge GREENE'S bridge, organized under a late charter from the State of New York, and acting under a charter of 1868 from the State of New Jersey. These two companies are about to unite. The officers claim that their united charter is strong and valid, and that no corpofation not having a Jersey charter can bridge the Hudson River. There is an assertion of state's rights in this position that may interest the United States, which on the broader ground of interstate commerce has already granted a similar right to another bridge.

THE CENTRAL HUDSON CAR WORKS, at West Albany, N. Y., were badly injured by fire on May 21. The blacksmith and machine shops were gutted and the loss is estimated at $150,000 to $200,000.

A SEWER-CLEANING APPARATUS, combining a wooden template driven by water accumulated in a flushing sluice, was used in 1889 for cleaning the sewers of Warsaw. It is described, but not clearly, in Abstracts from Foreign Publications, of the Institution of Civil Engineers, Vol. CIV., part II. The general description suggests the apparatus used in Boston, Mass., for a similar purpose and illustrated in ENGINEERING NEWS March 6, 1886.

THE READING TERMINAL, in Philadelphia, is being rapidly pushed, say the papers of that city. The masonry is under contract, many of the houses on the line have been removed and the contracts for the iron work are "soon to be let." The Supreme Court has not yet handed in a decision on the Market-house case, at 12th and Market Sts.

THREE-CENT FARES have been adopted by the Pittsburg Traction Co. for their line to East Liberty. This reduction in rates is brought about by the recent opening of the lines of the Duquesne Traction Co., a rival line. This is probably the cheapest fare in the United States on a road of this character, and the citizens of Pittsburg hopefully look forward to an equally low rate on all lines.

THE KINETOGRAPH is the latest reported invention of Mr. THOMAS A. EDISON. In an interview published in the N. Y. *Sun*, Mr. EDISON describes this still unperfected machine as an instrument with which he photographs a man or company of men in action at the rate of 46 per second. The negatives are ½ in. square, taken on a continuous film of gelatine of any length desired. By an ingenious arrangement the images from this gelatine ribbon are later thrown upon a screen, and this ribbon is made to move at a rate corresponding with the original rate of action; and at the same time a phonograph is made to repeat the words of the speaker represented. To thus photograph a 30-minute act of an opera, for example, a ribbon would be required 6,900 ft. long, each photograph ½ in. square requiring one inch of linear space. The commercial sphere of the kinetograph has not yet been defined.

THE TOTAL AND PER CAPITA INDEBTEDNESS of 70 foreign nations, the United States, the several States and the counties of the latter, is given in Census Bulletin No. 64, prepared by Mr. J. K. UPTON. The figures given, so far as possible, are for the years 1880 and 1890, the exceptions being some omissions and some figures not for the years named, but as nearly thereto as possible. The total indebtedness of the 79 foreign nations in 1890 is given as $25,636,075,840, or $33.36 per capita. For the United States the figures are, total, $915,962,112 and per capita $14.63, these figures being for the national debt alone. All the figures are for debt, less sinking funds. In the 10 years the debts for the 79 foreign nations have decreased from $34.14 to $33.36 per capita, or about 2.3%, while our national debt has decreased from $38.33 to $14.63, or over 61%. The greatest per capita debt in 1890 was in Queensland, $333.46, and the least in one of the Thuringian States, Reuss, Y. B., $0.53. The principal European countries had per capita debts in 1890 as follows:

France	$116.35*	Spain	$73 75
Great Britain	87.79	Russia	30 79
Italy	76.06	Germany	1.57

*Exclusive of annuities the capitalized value of which is estimated by some good authorities at two billion dollars, against 4.4 billions of debt, as taken in the tables.

The figures for the United States are as follows:

	Total debt, less sinking fund.		Bonded debt,	Floating debt,	Sinking fund,	Total debt, less sinking fund per capita.	
	1880.	1890.	1890.	1890.	1890.	1880.	1890.
United States	$1,922,517,364	$915,962,111	$711,313,110a	$204,649,002	.....	$38.33	$14.63
The several states and territories	290,326,643	223,107,883	223,128,544	47,804,012	$47,824,673	5.79	3.56
Counties	124,105,027	141,950,845	131,124,056	16,090,093	5,263,904	2.47	2.27
Totals	$2,336,949,034	$1,281,020,840	$1,065,565,710	$268,543,707	$53,088,577	$46.59	$20.46

a Less cash in treasury.

In the United States the heavier debts on the per capita basis are: District of Columbia, $85.86; Virginia, $18.76; Louisiana, $14.31, Arizona, $12.70, and Nevada, $11.13. In all the other States and territories the proportion is well below $10. Oregon has a debt of only 1 cent per head; Iowa, 13 cents, and Nebraska, 24 cents.

These figures have been commented upon in connection with previous bulletins, and are given again for convenience and for the sake any corrections to them which may have been made since the earlier bulletins.

THE NEW CROTON AQUEDUCT SUIT of Messrs. Clark & O'Brien against the City of New York is now on trial in this city. The contractors claim $800,000 for "extra work." Eminent counsel is engaged on both sides, and some very important questions, interesting both to contractors and to corporations, will be argued. One of these points is the extent to which the city is responsible for gross negligence or rascality on the part of its inspectors in permitting work of an inferior quality to be performed.

THE CINCINNATI ELECTRICAL SUBWAY CO. was organized in that city this week. Mr. CHARLES FLEISCHMANN is President, and Mr. NELSON W. PERRY is Electrician and Engineer. The object of the company is to build electric subways throughout the city, and in these to accommodate electrical conductors for all light and power companies. The company has been chartered by the state, but has yet to obtain the franchise from the city.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Cooperstown & Charlotte Valley.—This company will, it is stated, issue $45,000 of bonds to provide for the construction of the 3-mile extension to Davenport Center.

Philadelphia & Reading.—This company has made a contract with Coxe Bros. & Co., of Pennsylvania, for transporting all the coal produced from their mines. The terms of the contract call for the construction of 41 miles of railway by Coxe Bros. & Co., opening up the various sections of their coal properties. All but about 9 miles of this has been completed under the name of the Delaware, Susquehanna & Schuylkill R. R., described in our issue of Feb. 7, 1891. In addition to this the P. & R. will build a line from Lofty, Pa., on its Catawissa Branch to a connection with the Delaware, Susquehanna & Schuylkill R. R., a distance of about 10 miles.

Pittsburg & Western.—The stockholders of this company have voted the issue of $2,000,000 of bonds to be used in double tracking and otherwise improving the road-bed and terminal facilities of its road.

Saginaw, Trescola & Huron.—This company, now operating 66¼ miles of narrow gage railway between East Saginaw and Bad Axe, Mich., will change its track to standard gage. The rails and other necessary supplies have been contracted for. Work will begin at once. The company will dispose of its narrow gage rolling stock, comprising 7 locomotives, 8 passenger coaches, 5 baggage, express and way cars, 82 box freight cars, 9 stock cars and 129 flat cars. Contracts have been made for 6 standard gage locomotives, 9 coaches, 2 baggage and express cars. The contracts for freight cars have not been let yet.

Toledo, Ann Arbor & North Michigan.—Press reports state that this company will build a 55-mile extension north from Marion, Mich.

Philadelphia, Wilmington & Baltimore.—A bill has passed the Delaware Legislature authorizing the construction of a branch of the Delaware, Maryland & Virginia R. R., from Harbeson north to Milton, Del., about 5 miles.

Tobique Valley.—Mr. John E. Stewart, President, is reported as saying that about 50 men were at work grading the extension of this road to Plaster Rock, N. B. The road is projected to run from Perth Station to Plaster Rock, 28 miles. Up to June 1, 1891, about 6 miles of track had been laid.

Lake Erie, Alliance & Southern.—There is a report in circulation that this company will build extensions from Berghaltz, O., northeast to Steubenville, O., and from Phalanx, O., north to the Pittsburg & Western R. R.

Pennsylvania.—Work on the cut-off between Glen Lock, Pa., and Morrisville, N. J., 46 miles, is approaching completion. One track has been laid on the section between Norristown, Pa., and Morrisville, N. J., and the grading is nearly finished on the section from Norristown west to Glen Lock. The line will ultimately be double tracked, but at present only one track will be laid, with a 3,000-ft. siding every two miles. It is expected to have the entire line in operation by Oct. 1.

Quebec Central.—At the recent meeting of the stockholders of this company it was decided to build the proposed extension from Tring Station to Lake Megantic, P. Q., about 40 miles.

Pittsburg, Shenango & Lake Erie.—A correspondent writes that the tracklaying on this railway was completed to Girard Junction, Pa., on May 22, and that the road will be opened for traffic about June 5.

Baltimore & Ohio.—Work is being rapidly pushed on the Metropolitan Branch to Georgetown.—Tracklaying on the Akron & Chicago Junction R. R. has been completed between Chicago Junction and Warwick, O. It is expected to have the section from Warwick to Akron finished in about one month and the road opened for business.

Altoona & Wapsononock.—It is stated that this company will build an extension to Frugality, Pa., 7 miles. T. G. Patterson, Altoona, Pa., President.

Lake Hopatcong, Boonton, Morristown, Caldwell & New York.—The projectors of the proposed new railway from New York to Lake Hopatcong, N. J., met recently and effected a permanent organization by electing G. H. Scott, New York City, President; A. W. Cutter, Morristown, N. J., Vice-President; Jas. P. Sullivan, Morristown, N. J., Treasurer. It was voted that the capital stock should be $500,000. The estimated cost of constructing the road, including right of way, is $480,000. The people of the various towns through which the road will run have pledged amounts ranging in sums from $20,000 to $100,000. The directors present at the meeting subscribed $39,000.

Toledo, Walhonding Valley & Ohio.—The Northwestern Ohio Ry. Co. and the Walhonding Valley Ry. Co. have been consolidated under this name. The Northwestern Ohio Ry. belongs to the Pennsylvania Co., and runs from Toledo to Mansfield, O. The Walhonding Valley Ry. is projected to run from Kimbalton to Loudonville, O., 68 miles. It is stated that the contract for the latter line has been let.

Projects and Surveys.

Castine Railway & Navigation Co.—A. M. Devereux, of Bangor, Me., President, writes as follows:

This company, which is a reorganization of the old Castine & Bangor R. R. Co., has leased the rights and franchises of the Penobscot Central R. R. Co., and proposes to construct a railway from Castine, Me., via Bangor to Milo Junction, Me., a distance of 81 miles. The right of way has been largely secured or promised and about $1,000 per mile local aid secured. The work will be light; maximum grade 1% and maximum curve 4°. There will be two bridges across the Penobscot and Piscataquis rivers, 1,400 ft. long and 250 ft. long respectively. An arrangement has been made for the sale of bonds and construction of the road, and it is expected that work will begin this summer.

Concord & Rochester.—Organized in New Hampshire to build a railway from Concord to Rochester. President, Gustavus Walker; Treasurer, John C. Ordway, and Clerk, Jas. H. Walker.

Westerly & Jewett City.—There is some prospect that the section of this proposed railway from Voluntown to Jewett City, Conn., 7 miles, will be built. The road is projected to run from Jewett City to Westerly, R. I., about 25 miles.

Indiana.—A press dispatch says:

A large railroad meeting was held at Montpelier, Ind., recently, and an organization effected to build a railway from Union City, Ind., to Huntington. The following directors were elected: F. H. Allison, C. J. Allison, J. J.

Shaffer, J. C. Faucett, George L. Danforth, C. W. Pierce, A. Lupton, J. J. M. Lafollette, and G. A. Mason. The parties say the road will be built this year if sufficient aid is raised, and that the project is backed by plenty of money.

SOUTHERN.—Existing Roads.

South Florida.—It is reported that this company will change its line from Burton to Punta Gorda, Fla., to standard gage, and extend its line from Burton to Seville, Fla., about 100 miles

Danville & East Tennessee.—It is stated that the contract for building the 26-mile section from Bristol, Tenn., east, which was let to J. P. Edwards & Co., of New York City, has been annulled and relet to parties who will begin work June 1, and complete it this season.

Macon & Northern.—The Covington & Macon R. R. Co., whose property was sold at auction May 21 to parties representing the stockholders, has been reorganized under the above name. Alexander Brown, of Baltimore, Md., was elected President.

East Tennessee, Virginia & Georgia.—It is stated that this company has begun surveys for a line from Watauga Station, Tenn., to Allentown, Tenn. It is also stated that a line will be built from Allentown up the Little Doe River to mines, 11 miles.

Way Cross Air Line.—Construction has been resumed on the line between St. Mary's and Way Cross, Ga.

Carolina, Cumberland Gap & Chicago.—Contractor Geo. Potts has sublet the contracts for the line from Edgefield to Greenville, S. C., 34 miles. It is intended to put about 300 men and 100 teams at work at once.

Asheville & Craggy Mt.—About 100 men are now at work on this railway from Asheville, N. C., to the summit of Craggy Mt., and 1¾ miles of track have been laid. The road is to be completed July 4. It will be operated by a dummy engine.

Projects and Surveys.

Wheeling & Connellsville.—This company has organized with the following directors: W. A. Lynch, of Canton, O.; Judge R. H. Cochran, of Toledo, O.; Joseph Speidell, F. J. Hearne, George Wise, W. A. Isett, W. P. Hubbard, Cecil A. Robinson and Anton Reymann, of Wheeling, W. Va.

Arcadia, Gulf Coast & Lakeland.—The bill chartering this Florida company has been signed by the Governor. The charter provides for a road from Arcadia to Mitchellville and to Lakeland, with a branch to Tampa Bay and a branch to or near Shaw's Point. The company also proposes to build a line from Arcadia to Boca Grande. It is stated that the company has secured the necessary capital, and will begin work at an early date.

Waterloo & Cross Hill.—It is stated that J. T. Harris, of Waterloo, S. C., will build a dummy railway from Waterloo to Cross Hill, S. C., 5 miles.

Chipola & Chippewa Lake.—A bill has been introduced in the Florida State Legislature chartering this company to build a railway from Marianna to the Alabama line, with branches to St. Andrews and Chippewa Lake. Work is to begin within 6 months and be completed within three years. The capital stock is $1,000,000.

Florida Transportation Co.—A bill has been introduced in the Florida State Legislature incorporating this company with authority to build a railway from the mouth of the St. John's River to Charlotte Harbor. The incorporators are Arthur Meigs, Charles Baldwin and D. G. Ambler. The capital stock is $200,000.

Pensacola & Meridian.—It is stated that New York and Birmingham, Ala., parties have made a proposition to build a railway from Pensacola, Fla., to Meridian, Miss., on condition that Pensacola subscribes $100,000 and Meridian $200,000 in aid of the enterprise.

Archer & Dunellon.—There is talk of building a railway from Archer to Dunellon, Fla. H. L. Morris, of Timmonsville, S. C., is interested.

Blue Ridge.—This company, which was chartered at the last session of the North Carolina Legislature, has effected a temporary organization by electing S. T. Harper President.

Western Carolina.—This company has been organized in South Carolina to build a railway from some point on the Atlantic coast in South Carolina to Anderson, S. C., and thence to Chattanooga, Tenn. The officers are: President, E. B. Murray; Chief Engineer and General Manager, W. J. Kirk; Secretary, J. W. Bowdin, and Treasurer, J. A. Bock.

Alabama, Florida & Mississippi.—A bill has been introduced into the Florida State Legislature to incorporate a railway company by this name.

Hoffman & Tracy.—This company has been organized to build a railway from Hoffman to Troy, N. C., about 27 miles long. L. M. Jones is President, and D. A. McKinon is Secretary and Treasurer.

Carolina, Greenville & Northern.—A correspondent writes as follows:

This road is projected to run from Estillville, Va., via Greenville, Tenn., to Hot Springs, N. C., 83 miles. The preliminary surveys with maps, profiles and estimates, have been completed, and 40 miles are located. The work is light with the exception of 25 miles crossing the Unika Mountains; maximum grade 80 ft. per mile and maximum curve 50°. There will be 6 short tunnels and 3 bridges from 400 ft. to 600 ft. in length. The right of way and terminal facilities have been secured. Greene Co. has voted $.25,000 in bonds in aid of the enterprise, and the directors guarantee a subscription of $100,000 to the capital stock. The New York & Southern Construction Co. has the general contract for building the road and will sublet the work at an early date. The road is to be completed in 18 months. C. L. Rankin is President of the company and R. A. Bowie is Chief Engineer of both the railway and construction companies.

Gurleys & Paint Rock Valley.—F. B. Gurley, of Gurleys, Ala., President, writes as follows:

This road is projected to run from Winchester, Tenn., down Paint Rock Valley to Gurleys, Ala., and thence to Deposite, on the Tennessee River, about 65 miles. Surveys will begin in September. There will be two heavy grades, but the remainder of the work will be very easy. The right of way has all been secured and large subscriptions to the stock obtained from the people along the route. E. F. Walker, of Gurleys, Ala., is Secretary.

NORTHWEST.—Existing Roads.

Duluth & Iron Range.—It is stated that this company has a large party of engineers in the field surveying a line for the proposed extension to a connection with the Port Arthur, Duluth & Western Ry.

Kewaunee, Green Bay & Western.—The contract for building this Wisconsin railway from Kewaunee, Wis., to Green Bay, Wis., 25 miles, has been let to McIntosh Bros., of Milwaukee, Wis.

Chicago & New Orleans.—Work has been commenced on this railway from Farina, Ill., to the Ohio River, 130 miles. It is expected to have the section from Farina to Iuka, Ill., completed within 90 days.

Projects and Surveys.

South Sioux City & Homer.—A company has been organized to build a railway from South Sioux City to Homer, Neb., about 15 miles. Among the incorporators are, C. D. Smiley, R. B. Daley and Frank Hunt.

Chicago & Iowa Western.—A railway company by this name has been chartered in Iowa, with headquarters at Forest City. Among the incorporators are C. H. Kelley, J. W. Mahoney, A. A. Oleson and J. J. Thompson, all of Forest City.

Rapid City, Missouri River & St. Paul.—The preliminary survey has been completed from Rapid City, S. Dak., east to the Cheyenne River, about 40 miles, and it is stated that the line will be located in about two weeks. The contract for grading is to be let before June 10.

Duquoin & Marion.—The surveys for the proposed line from Duquoin to Marion, Ill., 37 miles, have been completed, and a very favorable route is stated to have been secured.

SOUTHWEST—Existing Roads.

Mississippi River & Bonne Terre.—S. C. Martin, of Bonne Terre, Mo., Chief Engineer, writes:

The contractors have 300 men and 100 teams at work on the Flat River extension of this road from Bonne Terre to Doe Run, Mo., 16 miles. The contractors are as follows: Draining, grubbing, grading and culvert masonry, John Scott & Sons; bridging, trestling, bridge masonry and foundation excavation, M. S. Corliter & Co.; crossties, Jno. Steinmetz. The route of the road is through a broken country and the work will be mostly loose rock and earth; maximum grade, 1.8%, and minimum curve 8°. There will be two 125-ft. deck spans, and one 100 ft. through span. The principal business of the road will be in minerals and timber.

Kansas City & Independence Air Line.—Wm. L. Taylor, Seventh and Wyandotte streets, Kansas City, Mo., writes that this railway is intended as a suburban belt line at Kansas City, Mo., and will be 5½ miles long. The contracts have been let to Smith & Bradbury, of Kansas City. The road to be completed in September. The route is rough, there being a 900-ft. elevation to overcome. Nearly all of the right of way has been secured.

Projects and Surveys.

Avoyelles Construction Co.—This company has been organized in Louisiana to build a railway from Bunker to Hamburg, La.

ROCKY MT. AND PACIFIC.—Existing Roads.

Astoria & South Coast.—Sixteen miles of this road are now completed and in operation from Astoria, Ore., to Sunside, Ore. Fifteen miles of railroad have been graded. Of this 7½ miles are from Sunside south and 7½ miles are from Hillsboro, Ore., north. Between the ends of grade, 71 miles, the surveys have been completed.

Valley (Montana).—Work has been begun on this Montana railway by the contractor, John Brady, of Helena, Mont. The road will run from Helena, Mont., northeast to the Missouri River, and thence to White Sulphur Springs, with branches to Castle and Lewiston.

Sumpter Valley.—Jos. A. West, of Baker City, Ore., Chief Engineer, writes as follows:

About 100 men and teams are now at work on this line from Baker City, Ore., to Fort Sumpter, 25 miles. Fifteen miles are now graded and it is expected to begin tracklaying July 1. The work will be heavy. W. D. Hendricks & Sons are the contractors.

Washington Southern.—The consolidation of the Seattle Lumber Co. and the Sutrop R. R. Co., under this name, mentioned in our issue of Feb. 14, has been completed. The company will extend its line to Gray's Harbor, Wash. A. H. Anderson, President; Geo. Lawler, Secretary.

Projects and Surveys.

Oysterville.—It is expected that work will begin on this line from Sealand to Stackpole Harbor, Wash., at once. A subsidy of $40,000 has been raised in aid of the enterprise. A. G. Hardesty is Secretary.

Tacoma & Seattle Air Line.—The project of building this railway from Seattle to Tacoma, Wash., about 30 miles, has been revived. The company was chartered about one year ago. The officers are Henry Bucey, President; J. C. Weatherred, Vice-President; Eugene Reith, Secretary.

Kettle Falls, Eastern Washington & Idaho.—This company has been organized to build a railway from Spokane, Wash., to Sand Point, Idaho, about 65 miles. G. C. Mills, Spokane, Wash., Chief Engineer.

Siuslaw & Eastern.—It is stated that this company has about 20 men clearing the right of way for its proposed railway from Eugene to Florence, Ore., 50 miles, and that grading will begin at once. A. G. Hovey, Eugene, Ore., President.

California.—Surveys are reported in progress for a railway from a point on the Merced-Oakdale branch of the Southern Pacific about 12 miles north of the Merced, Cal, up the Merced River toward Yosemite Valley. It is stated that the road will be built this season.

Salt Lake, Colorado & Gulf.—Chartered in Colorado to build a railway from Fort Wingate, on the Atlantic & Pacific R. R., in New Mexico, to Cortez, in Montezuma Co., Colo., and to extend the same from Cortez to Salt Lake City, and also to extend the line from Fort Wingate to El Paso or Galveston, Tex., and to construct branches from the main line to Rico, Dolores Co., Colo., to Durango, La Plata Co., and to Bluff City, Utah. Incorporators: Horace Brightman, Erastus F. Mead, Austin Stevens, James W. Hanna, Chauncy W. Blackmer and David H. Lemmon.

Butte, Anaconda & Pacific.—This company noted last week has been chartered. The route is described as follows:

From Butte City and the mines in its vicinity to the head of the Deer Lodge Valley; thence skirting the foothills lying south of the valley to Anaconda; thence up Warm Spring Creek to the divide, crossing it near the source of Flint Creek southwesterly to the east fork of Rock Creek; thence across Rock Creek to the west fork of said creek, and following the fork to the divide between Rock Creek and the Bitter Root River, crossing said divide near the source of Skalkaho Creek and following said stream downward to its junction with the Bitter Root River; thence down the Bitter Root Valley to Missoula; thence westerly to the western boundry of the state.

The principal office will be at Anaconda. The incorporators are William L. Hoge, Stephen A. Estes, Shelley Tuttle, William M. Thornton, Judson B. Losee. Surveys have begun.

FOREIGN.

Monterey & Mexican Gulf.—All the material necessary to complete the last 40-mile section of the extension to Tampico, Mex., has arrived, and it is expected to have the track laying completed by Aug. 1.

Mexican International.—It is stated that construction will soon be begun on the proposed extension from Torreon to Durango, Mex., 100 miles. The surveys have been made and the route approved by the Department of Public Works of Mexico.

Mexican, Cuernavaca & Pacific.—The preliminary survey for this line from the City of Mexico to Cuernavaca, Mex., has been commenced.

Lower California.—About 15½ miles of the preliminary survey have been completed for this line from San Quintin, Lower California, to Trinidad Pass, 75 miles. The grades and curves are easy.

Colima & Manganillo.—It is stated that the Mexican National Construction Co. will probably begin work in October on the extension from Colima to Guadalajara.

Honduras.—The Bureau of American Republics has furnished the following for publication:

The Government of Honduras has granted a concession to S. B. McCormic to construct a railway in the territory of Mosquitia, from the east coast to the interior, giving him 9 square miles of any unoccupied land that he may select for every mile of railway he may construct. It is further stipulated that he shall have the right to import free of duty all rolling stock, supplies, implements and provisions of food that may be required for the construction and equipment of the railway; that it shall be forever free from all taxation, either state or municipal, and that any foreign workmen he may introduce into the country for the construction of the road, and as settlers upon the lands that are granted him, shall be exempt from military duty and from the payment of personal taxes. Such settlers will have the right to import free of duty all tools, implements, machinery, etc., necessary for the cultivation of their lands and the preparation of their crops for market. The company is also granted the right to cut mahogany and other timber on government lands upon the payment of $5 for each mahogany tree.

CITY TRANSIT.

Electric Railways.—New lines or extensions of existing lines are reported as probable in the following places: Charlottesville, Va., address the Charlottesville & University Street Ry. Co.; Atlanta, Ga., address the East Lake Land Co.: Houston, Tex., address the Houston Rapid Transit Co.; Eureka Springs, Ark., address the Eureka Springs Electric Light & Ry. Co.; Cedar Rapids, Ia., address the Cedar Rapids & Marion City R. R. Co.; New Albany, Ind., address J. H. Statsenberg, Indianapolis, Ind.; Belfast, Me., address R. F. Peirce.

Cedar Rapids, Ia.—The Thomson-Houston Co. and the Cedar Rapids & Marion Ry. Co. have consolidated their interests and will at once begin work on the electric railway for which the City Council granted the Thomson-Houston Co. a franchise a few weeks ago. A capital stock of $400,000 is authorized. The following officers were elected: James L. Piver, President; Walter

D. Douglas, Vice-President; Charles H. Clark, Treasurer: Glenn M. Averill, Secretary.

Marion, Ind.—The line of the Marion Street Ry. Co., is being extended and changed to an electric line. The Thomson-Houston Co. has the contract.

Indianapolis, Ind.—It is reported that a company will be organized to build a system of electric railways at this place.

St. Louis, Mo.—The Underground Electric Traction Co. has been chartered at St. Louis, Mo. Incorporators: J. B. Sheldon, D. J. Murname, G. L. Van Beck, Joseph O'Shea and W. J. Kennedy.

Florence, Ala.—It is stated that the Florence dummy line will be changed to an electric line.

Cable Railways.—***Baltimore, Md.***—The Rapid Transit Ry. Co., composed of J. P. R. Polk, Henry Bowers, Sr., Harry W. Rusk and others, have applied to the City Council for a franchise to construct a street railway. It is contemplated building two main lines through the city to be operated by cable power, and several branch lines to be operated by the storage electric system. The amount it is proposed expending is from $4,000,000 to $5,000,000.

Knoxville, Tenn.—The Knoxville Real Estate Exchange is building a cable railway at this place.

Elevated Railways.—***Brooklyn N. Y.***—The consent of nearly all the property owners along the proposed extension of the Brooklyn Union Elevated Ry. has been obtained, and the construction of the line will probably begin soon.

Horse Railways.—***Ennis, Tex.***—The Ennis Street Ry. Co. has been granted a franchise for building a street railway.

New Companies.—Beaumont Street Ry. Co., Beaumont, Tex., capital stock, $100,000; directors, F. P. Gayne, H. L. Brennan, Chas. F. Renney, and others; Lake Park Street R. R. Co., Waxahachie, Tex., capital stock, $20,000; directors, S. H. Griffin, W. F. Lewis and others; Arcadia Street Ry. Co., Arcadia, Fla.; Anthony Peters, Homer Rogers and Fred. C. Peters; Trenton Street R. R. Co., Trenton, N. J., capital stock, $6,000; Atlanta Consolidated Street Ry. Co., Atlanta, Ga., directors, H. E. W. Palmer, Joel Hurt and others; Interstate Street Ry. Co., Providence, R. I.; Santa Monica & Soldier's Home R. R. Co., Los Angeles, Cal., W. S. Vawter and others.

HIGHWAYS.

Washington.—Chehalis County, Wash., is much agitated over a proposition to vote bonds for the purpose of building county roads. The fight is made against the bonds because most people of any experience believe that too many roads are proposed to be built with the money to be raised. Some $280,000 will be available for road-building, which only allows about $1,000 per mile for the roads proposed to be built. This amount will scarcely cut a hole in the woods, and many taxpayers are opposing it because of the waste of money. However, it is stated that there is so much actual need for roads that there is not much fear of the bonds being voted on general principles.

BRIDGES, TUNNELS AND CANALS.

Bridges.—***Niagara Falls, N. Y.***—A petition has been presented to the Canadian House of Commons by the Hon. Mr. Kirkpatrick from Sir Donald A. Smith, W. C. Vanhorne, R. B. Angus, T. J. Shaughnessy, and G. M. Clark, of Montreal, G. R. Ham, of Boston, and R. M. Wells, of Toronto, asking for incorporation as the New York & Ontario Bridge Co., with power to build a railway bridge across the Niagara River at or near the town of Niagara Falls, and to amalgamate said corporation with the company incorporated in the State of New York.

Logan, W. Va.—A company has been chartered to build a bridge over Tug River in Logan Co., W. Va.

Greenville, Miss.—C. M. Johnson will receive sealed bids until June 15 for the construction of a bridge across Silver Lake and one across Blackbird bayou, in Washington Co.

Sioux City, Ia.—Articles of incorporation of the Iowa & Nebraska Bridge Co. have been filed. Its purpose is to construct and operate a bridge across the Missouri at Sioux City. The capitel stock of the company is $2,000,000. Henry T. Oxnard is President; John M. Moan, Vice-President, and Frank Hunt, Secretary and Treasurer.

Canals.—A bill has been introduced in the legislature at Tallahassee, Fla., to incorporate the Atlantic & Gulf Canal Co., and providing it with the right to construct a canal from deep water at Cedar Keys, Fla., through Levy, Marion and Putnam counties, and thence down the St. John's River to the Atlantic Ocean; right of way 200 ft. wide is granted. The incorporators are: C. W. McLean, of Ohio; R. W. Daniels, of New York; J. C. Davis, of Maryland, and others; capital stock, $100,000,000; general office at Jacksonville.

WATER-WORKS.

NEW ENGLAND.

Freeport, Me.—W. A. Mitchell, Town Clerk, has sent the following:

The town has voted to give a franchise to E. B. Mallet. Water will be pumped from springs to a stand-pipe at an estimated cost of $30,000. Population 1,200.

Gorham, Me.—A company has been chartered.

Phillips, Me.—The Phillips Water Co. organizes May 30 and decides whether it will begin construction next week.

Fairhaven, Mass.—It is reported that the Fairhaven Water Co. is laying a section 6-in. pipe to save its charter. It is hoped that construction of the whole works can soon be started; estimated cost, $110,000. J. K. Nye is at the head of the project.

Leominster, Mass.—Old mains will be replaced with new iron pipe.

Orange, Mass.—A committee of five has reported in favor of a new water supply from North Pond, one mile from the village; estimated cost, including pumps, $110,000. E. A. Goddard has been instructed to secure an enabling act from the legislature. A company has offered to build works if the village will take 50 hydrants at $50 each per annum.

Naugatuck, Conn.—E. C. Barnum Secretary, informs us that the contract for a reservoir has been awarded to O. M. Weand, Reading, Pa.

MIDDLE.

Brooklyn, N. Y.—Contracts for nearly $300,000 worth of pipe have been awarded as follows: 2,800 tons 48-in., 229 tons 36-in., 560 tons 30-in., 286 tons 20-in. and 8 tons 12-in., at $25.10 per long ton, or $98,216 for the whole, to R. D. Wood & Co., Philadelphia; 3,500 tons 48-in. pipe at $24.50 per ton and 210 tons of specials at $53.76, or $97,039 for the whole, to John Fox, Agent Reading Foundry Co.; 3,920 tons 48 in. pipe at $24.80 per long ton, or $97,216 for the whole, to the Warren Foundry & Machine Co., Phillipsburg, N. J. The pipe will be used for new supply mains in the city.

East Randolph, N. Y.—Wren & Chapman, Castile, have the contract for the village works; price, $11,500.

Hermon, N. Y.—The contract for a 20-ft. Halladay windmill and 50,000-gall. tank, 1,914 ft. of 6, 2,610 ft. of 4 and 1,476 ft. of 3-in. pipe, and labor, has been awarded to the U. S. Wind Engine & Pump Co., Batavia, Ill.

Mechanicsville, N. Y.—Surveys for works are proposed.

Prescott, N. Y.—Water-works and sewerage are advocated by the Prescot *Journal*; estimated cost, $75,000.

Rochester, N. Y.—Mains will be laid on several streets.

Schenectady, N. Y.—An appropriation of $4,000 has been made to pay for a 20-ft. experimental well.

Altoona, Pa.—Paul Kreuzpointner informs us that the election to vote $220,000 for a new water supply was in favor of the proposition by a large majority.

Lebanon, Pa.—The Brandywine Water Co. has been chartered; capital, $3,000.

Reading, Pa.—In July a vote will be taken on the issuance of $150,000 bonds for a new or increased supply.

Elkton, Md.—The franchise has been granted to Young Bros., Philadelphia. There will be 19 hydrants, and the works must be completed by Oct. 1.

SOUTHERN.

Radford, Va.—The Citizens' Water & Light Co. is being organized to supply the eastern section of the town, and about $15,000 of stock has been subscribed for. W. P. Gunn is Secretary.

Parkersburg, W. Va.—The Spring Water Supply has elected Z. T. Taylor, President, and S. F. Shaw, Vice-President and Superintendent, and W. M. Straus, Secretary. It is expected that construction will soon be started. A pump, reservoir and stand-pipe are proposed.

Macon, Ga.—The Highland Park Loan & Improvement Co. has been organized by H. R. Dill, C. E. Marvin and others to establish a village, build water-works, etc.; capital, $30,000.

Macon, Fla.—The city will probably employ an engineer to report on works and there is talk of securing authority from the legislature to build works. The present supply is furnished by a company.

West End, Ga.—J. A. Caldwell, City Clerk, wishes prices on a 100-ft. water tower, 10,000 of 8 and 10,000 ft. of 6 and 4-in. pipe, also on hydrants.

Luverne, Ala.—Works are projected.

Opelika, Ala.—The franchise granted to the American Pipe Manufacturing Co. provides for 6 miles of pipe and 60 hydrants.

Ozark, Ala.—About $8,000 is to be expended in establishing a system of water supply and electric lights. N. Wilson Davis, Atlanta, Ga., is Engineer.

Troy, Ala.—The following information has been received:

The city has decided to build works instead of granting a franchise. N. Wilson Davis, Atlanta, Ga., has been engaged to prepare plans and specifications for a system to include 5 miles of 10 to 4-in. mains and 37 triple-nozzle fire hydrants. Estimated cost, $35,000. Water will be pumped to a 150,000-gall. stand-pipe. Bids will be wanted about June 15.

Uniontown, Ala.—Plans and specifications are being prepared for a complete system of works by N. Wilson Davis, Atlanta, Ga.

NORTH CENTRAL.

Bridgeport, O.—Works are being designed by Dunham & Paine.

Cincinnati, O.—Proposals are wanted until June 13 for four steel boilers, 5 × 24 ft., with four 11 and two 16-in. flues; also for five steel boilers, 4½ × 24 ft., with four 9 and two 13-in. flues; also for two steel boilers, 5 ft. 2 ins. × 28 ft., with one 18 and four 14-in. flues. For information address W. P. Sharp, Superintendent water-works.

Haselton, O.—A reservoir, to be filled from springs, is talked of. A general supply from Youngstown has been proposed, but it is thought to be impracticable.

Niles, O.—Bids are wanted until June 30 for water-works, as outlined in our advertising columns.

North Baltimore, O.—Coon & Son, Upper Sandusky, O., have made a proposition for a supply.

Indianapolis, Ind.—The mains will be extended.

Irvington, Ind.—Works are projected.

Hancock, Mich.—Plans for water-works and sewers will be made by C. F. Loweth, St. Paul, Minn.

Litchfield, Ill.—The Litchfield Water Supply Co. has been incorporated by Frank B. Milner, Daniel W. Taylor and others; capital, $15,000. It is reported that the Council has passed an ordinance authorizing a company to pump and supply to the reservoir through a new main from Shoal Creek.

Morton Park, Ill.—A supply from wells is projected.

Peru, Ill.—It is reported that contracts for works to cost $64,000 have been let.

NORTHWESTERN.

Manson, Ia.—The following is from E. B. Larmon:

Contracts for works estimated to cost $4,000 will be let June 5. Water will be pumped from a well to a tank.

Friend, Neb.—Works are to be built at an estimated cost of $20,000, with A. A. Richardson, Lincoln, Designing Engineer.

Schuyler, Neb.—W. T. Howard has sent the following:

Bonds for works have not yet been sold, but it is hoped construction can be started July 1. The supply will be pumped from a large reservoir to a stand-pipe. Estimated cost, $25,000. Population, 2,160.

Vermillion, S. Dak.—It is reported that the Michigan Pipe Co., Bay City, Mich., will put in works at an estimated cost of $30,000; also that there will be five miles of mains, 50 hydrants, an artesian well and direct pumping, with a small reservoir.

Dillon, Mont.—A franchise has been granted to J. P. Lawrence, of Helena, and others. There will be 20 hydrants. The same parties have an electric light franchise.

Great Falls, Mont.—The following is from E. W. King, Superintendent:

The Council has ordered 2 miles of new mains. company thinks of laying a main to West Great Falls, which will include 1,100 ft. of pipe under the Missouri River. A 5,000,000-gall. pump and a stand-pipe are also proposed.

It is reported that the Boston & Montana Co. are about to build a large reservoir in a gorge, to which water will be pumped from the Missouri River.

SOUTHWESTERN.

Moberly, Mo.—The property of the Moberly Water-Works Co. will be sold at auction on June 10 at Huntsville, Mo., by Charles Parsons, trustee for the bondholders.

Nevada, Mo.—Charles F. Strohm, New York, has been appointed as Receiver of the Nevada Water Co.

Prescott, Ark.—The following is from J. H. Arnold, Mayor:

The town wishes either to let a contract or grant a franchise for works to take a supply from wells. Population, 800.

Texarkana, Ark.—M. P. Hillyer, President, Topeka, Kan., has sent the following:

The works here and at Texarkana, Tex., have been consolidated and the Texas pumping station abandoned. The company expects to add 4 miles of mains, set 20 hydrants and sink 16 wells.

Dallas, Tex.—Bids are wanted until June 3 for $100,000 of water and $150,000 of 5% sewer bonds.

Ladonia, Tex.—The following is from W. A. Anderson, Secretary:

The Ladonia Artesian Water-Works Co. proposes to secure a supply from a 5¾-in. well from 1,000 to 2,500 ft. deep. A strong flow is hoped for. C. W. T. Weldon is President. Population, 1,500.

St. Elmo, Col.—The following is from A. W. Root, Town Clerk:

The town proposes to build works at an estimated cost of $4,000, taking a supply from a mountain stream, by gravity. There will be a ditch 2,000 ft. long, for which the contract has been let, and about 2,600 ft. of supply main with a fall of 200 ft. Works will be built from time to time as money can be raised to pay for them. The altitude is 10,000 ft. Population, 500.

PACIFIC.

Seattle, Wash.—The purchase of two 6,000,000-gall. pumps has been recommended. Negotiations for the purchase by the city of the works of the Union Water Co. are in progress.

Tacoma, Wash.—The Tacoma Light & Water Co has been enjoined by the Superior Court from taking a temporary supplementary supply of water from American Lake. The question will probably be carried to the State Supreme Court.

East Portland, Ore.—It is reported that the property of the water company will soon pass into the city's hands by purchase.

Redlands, Cal.—The Redlands, Lugonia & Crafton Domestic Water Co. expects to build a new reservoir and lay 2 miles of larger pipe to supply West Redlands and Terracina. It is reported that the company has disposed of its irrigation interests.

Oakland, Cal.—The suburb called Piedmont, it is reported, will be supplied from springs developed by tunneling and conveyed to and from a reservoir by gravity. W.

J. Dingee is at the head of the project. W. L. Boardman is said to be the Engineer.

Moscow, Ida.—The people will vote on the issuance of $100,000 of bonds for water-works, sewers, macadam streets and a new city building.

CANADA.

Quebec, P. Q.—The Water Works Committee are considering the construction of a new dam at the Chateau d'Eau, Lorette.

Sandwich, Ont.—The Council proposes to submit a by-law to the taxpayers to see if they will vote to raise $15,000 to lay mains, the supply to be obtained from Windsor at 20 cts. per 1,000 galls.

ARTESIAN WELLS.

River Forest, Ill.—An artesian well for water-works may be sunk. Address E. C. Waller.

Yankton, S. Dak.—Bids are wanted until June 5 for sinking an 8 and a 6-in. well 1,000 ft or less. Address Secretary Yankton Land & Improvement Co.

Helena, Mont.—A company has been organized to complete a well near the residence of William Muth. The well is now down 1,000 ft., and it is thought that water will be secured at 1,800 ft.

Dublin, Tex.—R. H. McCain informs us that the Dublin Water-Works Co. is now boring for water.

Mineola, Tex.—J. H. Newsome, City Secretary, will receive bids for a well.

IRRIGATION.

Marsland, Neb.—The preliminary surveys of the Marsland Irrigation & Improvement Co are for a ditch 32 miles long.

Douglas, Wyo.—The Douglas ditch is being located. Capital for its construction has not yet been secured.

North Great Falls, Mont.—A. Holden has the contract for 14 miles of the Cascade Land Co.'s ditch. Work has just been started.

New Companies.—Burwell Water & Power Irrigation Co., Burwell, Neb.; $25,000. Court House Rock Irrigation Co., Midway, Neb.; $6,000. Kearney Irrigation & Water Co., Kearney, Neb.; $6,000. Western Irrigation & Mining Pump Co., Platteville and Denver, Col.; $100,000; to manufacture and sell irrigating and mining pumps, etc. Towyall Reservoir & Ditch Co., Denver, Col.; $400,000; to operate in Park, Jefferson and Arapahoe Cos. Klamath Irrigation Co., Linkville, Ore.; $20,000. Milton Irrigation & Improvement Co., Milton, Ore.; $500,000. W. S. Frazier, R. T. Morris; take water from Walla Walla River. Tumalum Irrigation Co., Milton, Ore.; $100,000. Ira W. Berry, A. E. Bostwick; take water from Tumalum River for irrigation, manufacturing and domestic supply. Redland Heights Water Co., Redland, Cal., $500,000, of which $64,000 has been subscribed; E. G. Judson, President and Richard Archer, Secretary.

SEWERAGE AND MUNICIPAL.

Sewers.—*New Hampshire.*—Lebanon is discussing sewers.

Massachusetts.—Brockton aldermen have authorized a $10,000 sewer loan.——North Adams will begin the construction of a $40,000 sewer as soon as pipe arrives.——At Palmer surveys for sewers have been begun by J. J. Van Walkenburg.——Pittsfield's Mayor and Treasurer have been authorized to issue $100,000 of 6% 30-year sewer bonds, as needed.——Waltham's aldermen have authorized the issuance of $150,000 of sewer construction bonds.——At Westboro surveys for sewers have been completed and it is thought that the people will soon vote for their construction.

New Jersey.—At South Orange the Village Trustees have passed an ordinance in favor of constructing a sewerage system. A sewage farm is proposed. C. P. Bassett, Newark, has reported on the subject.

Maryland.—At Baltimore it is reported that $48,500 has been appropriated for sewers, in addition to what was noted last week.

South Carolina.—Greenville projects sewers at an estimated cost of $15,000 to $20,000.

Georgia.—It is reported that sewers are being put in at Adairsville.

Tennessee.—Nashville's Council has appropriated about $60,000 for sewers in three streets.

Indiana.—Anderson's Council has authorized the construction of a $75,000 sewerage system.

Illinois.—Freeport is putting in about 11 miles of sewers at an expense of $40,000 or more.——Ottawa is considering sewers, and Andrew Rosewater, Omaha, has been making examinations.——Streator's Council has appropriated $1,400 for sewerage surveys and plans.

Montana.—At Great Falls the building of a 4-ft. brick sewer on Sixth St., to the river, is being discussed.

Colorado.—The town of Highlands has voted $40,000 of sewer bonds, which will soon be for sale.

Streets.—*Massachusetts.*—At Quincy $10,700 has been appropriated for rebuilding Hancock St.

New York.—Greenbush is to have considerable paving done.——In New York the Morgenthau Syndicate has obtained permission to open, at their own expense, 179th, 180th and 182d Sts., between Kingsbridge Road and Amsterdam Ave.

New Jersey.—At Cape May there is talk of extending the beach drive to the Mt. Vernon tract.

Delaware.—At Wilmington the Council will be asked to appropriate $100,000 for street improvements from the $500,000 authorized recently. It is proposed to expend the remaining $100,000 in 1892 and 1893.

Alabama.—At Mobile W. P. McCrossin has made a proposition to supply chert for paving at 40 cts. per cu. yd. on the cars.

Tennessee.—Bristol has voted $50,000 for street improvements, city courthouse and market.——At Harriman the East Tennessee Land Co. are authorized by the directors to expend $25,000 for street improvements.——Jackson will vote June 2 on the issuance of $55,000 of bonds, $20,000 being for street improvements.

ELECTRICAL.

Electric Light.—New plants or additions to existing plants are reported as probable at the following places: Atlanta, Ga., address R. R. Lockett, Mayor; Anniston, Ala., address the Anniston Gas & Light Co.; Paris, Tex., address the Mayor; Merlin, Tex., address the Mayor; Lake Charles, La., address the Mayo Poe Shingle Co.; Convers, Ga., address J. R. Maddox, Mayor; Cedartown, Ga., address the Mayor; Greenville, S. C., address the Greenville Gas, Electric Light & Power Co.; Petersburg, Va., address the City Point Land & Improvement Co.; Greensboro, N. C., address J. A. Odell; Athens, Tenn., address M. M. Henderson, Chattanooga, Tenn.; Elizabeth City, N. C., address the Elizabeth City Electric Light Co.; Wheeling, W. Va., address the Mayor; Cincinnati, O., address the Corporation Counsel; Hamilton, Wash., address J. L. Warner; Lafayette, La.; Redlands, Cal.; Santa Fé, N. Mex., address F. T. Webber.

Vallejo, Cal.—The contract for furnishing 40 arc lamps of 2,000 c. p. has been let to J. G. Gardner and others for $590.

New Companies.—Princeton Electric Light & Power Co., Princeton, Ill., capital stock $50,000; Noblesville Water & Light Co., Noblesville, Ind., capital stock $50,000; Clinton Electric Light & Power Co., Clinton, Ind., capital stock $10,000; Jackson Center Electric Ry. Signal Co., capital stock $1,000,000; Paterson Electrical Manufacturing Co., Paterson, N. J., capital stock $100,000; W. D. Graves Electrical & Manufacturing Co., Cleveland, O., capital stock $25,000; Electric Motor Works, Fort Worth, Tex.; Dunellen Electric Light Co., Dunellen, N. J., capital stock $5,000, incorporators, H. N. Spencer and W. R. Codington, of Plainfield, N. J., and others.

CONTRACTING.

Street Work.—*Boston, Mass.*—The contract for 300,000 large paving blocks has been awarded to the Cape Ann Granite Co., at $72.95 per thousand, on wharf.

Fall River, Mass.—The contract for 160,000 paving blocks has been awarded to J. H. West, Franklin, Me., for $75 per thousand, on wharf; for 9,000 ft. of edgestones, Maxime Jean, Fall River, 77 cts. per ft., delivered on the work.

Greenbush, N. Y.—The contract for paving on Broadway has been awarded to Henry Dumary, Albany, as follows: Dimension granite block pavement, $2.70 per sq. yd.; curbing, 85 cts. per sq. yd.; cross-walks, 80 cts. per sq. yd.

Wilmington, Del.—The Brandywine Granite Co. has been awarded the contract for granite blocks at $1.52 per sq. yd. William Campbell has been awarded the contract for grading on Franklin St. at 13 cts per sq. yd.

Sewers.—*Kansas City, Mo.*—The contract for constructing a sewer in District 156 has been awarded to James Pryor, as follows: $1.10 per ft. 21-in. pipe, 60 cts 15-in. pipe, 47½ cts. 12-in.; $25 each for six manholes; $40 for catch basins.

Dredging.—On May 20, Lieut. Col. P. C. Haine, Corps of Engineers, U. S. A., received bids for dredging as follows: Aquia Creek, Va., Frank C. Somers, Camden, N. J. 12½ cts., and T. P. Morgan, Washington, 20 cts. per cu. yd.; Rappahannock River, Va., 31 cts., and Urbana Creek, Va., 26½ cts., both from F. C. Somers.

Stone.—The only bid received by Maj. C. W. Raymond, U. S. Engineer Office, Philadelphia, for stone for the Delaware breakwater, was from the Brandywine Granite Co. Wilmington, Del., $2.17 per ton.

PROPOSALS OPEN.

Sewers.—*Boston, Mass.*—Sewer 10 to 13 ft. in diameter; 2,100 ft., average depth of 19 ft.; 3,050 ft., 27 ft. deep. Metropolitan Sewerage Commissioners, 93 Lincoln St., Boston. June 13.

Kearney, N. J.—Pipe sewer on one street, brick on another. William Logan, Township Clerk. June 9.

Washington, D. C.—About 62,000 ft. 6 to 24 terra cotta pipe, terra cotta Y branches and ⅛-in. bends, 9,000 lin. ft. terra cotta invert blocks, and 450,000 vitrified fire bricks. Commissioners District Columbia. June 8.

Clinton, O.—Six-inch sewers, 5,000 ft. C. P. Chase, City Engineer. June 9.

Carson City, Nev.—About 25,600 ft. vitrified iron stone sewer pipe; excavating and back filling; 40 bbls. or more Portland cement delivered. W. H. Doane, City Clerk. June 6.

Streets.—*Terre Haute, Ind.*—Gravel grading, wood curbing, cinder or gravel sidewalks on three streets. A. C. Duddleston, City Clerk. June 16.

Clinton, Ia.—Brick paving, 100,000 sq. yds.; 30,000 cu. yds. grading, 35,000 lin. ft. stone curbing, 7,000 lin. ft. brick curbing. C. P. Chase, City Engineer. June 9.

St. Louis, Mo.—Furnishing and hauling macadam, screened gravel, red or cement gravel, constructing new and repairing old sidewalks, repairing alleys, gutters curbs and sidewalks for the year beginning July 1, 1891. Also furnishing and setting six public drinking fountains. E. S. Smith, Secretary Board Public Improvements. June 9.

Montreal, P. Q.—Paving six streets with block stone, 15 with rock asphalt, 9 with wooden blocks. P. W. St. George, City Surveyor. No date.

Water-Works.—Water-wheels will be wanted by the Nims Manufacturing Co., Mt. Holly, N. C.

Buffalo, N. Y.—Material and labor for improvements to water-works, including six cylinder boilers and 600 iron hydrant cases. Water Commissioners. June 4.

Rails.—Prices on 145 tons, more or less, of second 30-lb rails, delivered at Atlanta, Ga. J. A. Devlin, Due West, S. C.—Steel rails, frogs, spikes, etc. Navy Department, Washington, D. C.

MANUFACTURING AND TECHNICAL.

Cars.—The Roanoake Machine Works has received orders from the Norfolk & Western for 100 hopper bottom gondolas and 100 flat cars. It is reported that the Lafayette branch of the Lafayette Car Works will be removed to Lima, O., and consolidated with the works there as the Ohio Car Manufacturing Co. The New York, Lake Erie & Western has placed an order with the above works for 500 cars. The Cincinnati, Hamilton & Dayton are preparing plans and specifications for 600 freight cars to be built at their shops in Lima, O. The Youngstown, O., Car Co., has received an order from the Pittsburg & Lake Erie R. R. Co. for 500 gondolas.

Meters.—The Thomson Meter Co., of New York, has just had issued to it nine additional patents on improvements to their water meters. The list is long, and from their titles they are evidently important in their bearing on the greater perfection of the mechanism.

Electric Lights.—Electric lighting plant. A. L. Sackett, Secretary Trustees Minnesota Hospital for Insane, Merchants' Hotel, St. Paul. June 9.

Bonds.—Sewer bonds, 4%, $10,000 or less. Selectmen, Bradford, Mass.—General Improvement bonds, 4½%., $25,000. S. G. Sterling, Village Clerk, Clifton, O.—Harbor bonds, 4%, $150,000. Alexander Robertson, Secretary Montreal, P. Q., Harbor Commission. June 2.

Block Signals.—We are informed that the Hall system of automatic electric block signals has been accepted and adopted by the New York Central & Hudson River R. R. Co. for the protection of the most dangerous portion of their line, after being subjected to a seven months' test.

Electric Drills.—The Edison General Electric Co. has established a plant of 10 electric percussion drills in the Black Bear mine, owned by Mr. O. B. Hardy, in the Cœur d'Alene mining district. The cost of the plant was about $8,000. The company is to run the drills successfully for 40 days before the plant is accepted.

Companies.—Newark Sanitary & Manufacturing Co., Newark, N. J., to manufacture an "absorbent of night soil;" Edward Records, Newark; C. W. Dougherty, Augusta, Ga.; Franklin Noble, New York; $150,000. Nier Engineering Co., St. Louis, Mo.; John W. Nier, Arabelle Nier and S. A. Mitchell; $5,000.

Metal Market Prices.—*Rails.*—New York: $30.75 to $31; old rails, $20.50 for iron and $17 for steel. Pittsburg: $30; old rails, $24 for iron and $17 to $18 for steel. Chicago: $31; old rails, $22.75 for iron and $14.50 to $17 for steel.

Track Materials.—New York: steel angle bars, 1.7 to 1.75 cts.; spikes, $1.9 to $1.95; track bolts, 2.60 cts. with square, and 2.75 cts. with hexagon nuts. Pittsburg: splice bars, 1.80 to 1.90 cts. for iron or steel; iron or steel spikes, 2.05 cts.; iron track bolts, 2.75 cts. with square, and 2.85 cts. with hexagon nuts. Chicago: splice bars, 1.85 to 1.9 cts. for iron, 2 to 2.05 for steel; spikes, 2 to 2.1 cts.; track bolts, 2.8 to 2.9 cts. with hexagon nuts.

Foundry Pig Iron.—New York: $14 to $16. Pittsburg: $14.25 to $16.75. Chicago: $14.50 to $16.

Pipe.—Cast iron, $25 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 55 and 45 per cent. on black and galvanized butt-welded; 65 and 52½ on black and galvanized lap-welded. Casing, 55 per cent.

Lead.—St. Louis: 4.15 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 1.95 to 2.1 cts.; tees, 2.45 to 2.75 cts.; sheared iron plates, 1.95 to 2.25 cts.; steel plates, 2 to 2.15 cts. for tank, 2.3 to 2.6 cts. for shell, 2.5 to 2.7 cts. for flange, 3.75 to 4.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 cts.; tees, 2.65 cts.; universal iron mill plates, 2.1 cts.; sheared steel bridge plates, 2.1 cts.; refined bars, 1.8 to 1.9 cts.; steel plates, 2.1 to 2.15 cts. for tank, 2.45 to 2.5 cts. for shell, 2.7 cts. for flange, 3.9 to 4.25 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.25 to 2.3 cts.; tees, 2.6 to 2.7 cts.; universal plates, 2.3 to 2.4 cts.; sheared plates, 2.5 to 2.6 cts. for iron and 2.6 to 2.7 cts. for steel; steel plates, 2.6 to 2.7 cts. for tank, 3.25 cts. for shell, 3.5 cts. for flange, 4.25 to 5.5 cts. for firebox; boiler rivets, 4 to 4.25 cts.